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The Mining Magazine

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EDITORIAL

AN exhibition, to which over 12,000 designers and technologists have been invited, is being staged by the Mond Nickel Company at Marlands Hall, Havelock Road, Southampton, from October 27–30, featuring the properties of nickel, nickel-containing materials, and the platinum metals. Different sections will deal with mechanical and physical properties, corrosion resistance, electrodeposition, strength at high temperatures, toughness at sub-zero temperatures, and welding. On each day a number of films will be shown relating to particular aspects of the exhibition and representatives of the company's development and research department will be in attendance.

AN international symposium on powders in industry is to be held by the Surface Activity Group of the Society of Chemical Industry on September 29 and 30, 1960, at the Royal Institution. The chairman of the Group is Sir Eric Rideal and the chairman of the Organizing Committee is Dr. M. G. Fleming. The purpose of this meeting, it is stated, is to bring together scientific and technological representatives of some of the many industries in which fine powders are of importance, whether as raw material, an intermediate processing stage, or final product, and to provide opportunity for discussing problems of mutual interest in widely diverse industrial fields. The application of powders is so varied that many of the users may be unaware of developments in otherwise unrelated industries which could assist them.

IT has recently been announced by the Canadian Department of Mines and Technical Surveys that the ore-processing activities of the Mines Branch are to be re-organized. The units affected are the Mineral Dressing and Process Metallurgy, Industrial Minerals, and Radioactivity divisions. The activities of these have been regrouped and three new divisions formed, to be called Mineral Processing, Extraction Metallurgy, and Mineral Sciences. The new Mineral Processing division is to be composed of the former Industrial Minerals division and the Mineral Dressing section of the former Mineral Dressing and Process Metallurgy division, while the new Extraction Metallurgy will include the main groups of pyrometallurgy and hydrometallurgy development, of which the former Radioactivity division will form a part. The new Mineral Sciences part will then cover analytical chemistry, mineralogy, physics, and radiotracer work, as well as the physical chemistry groups.

The Mines Branch, of which Dr. John Convey is the director, has, it is pointed out, three other divisions—the Physical Metallurgy, which will continue to cover practically all phases of physical metallurgical science and engineering ; the Fuels division, which has been renamed Fuels and Mining Practice, and Technical Services, which attends to various requirements of the Branch's other five divisions.

Looking Back

In the present issue of the MAGAZINE there is included the first part of a critical survey of progress in metal-mining techniques by Mr. G. Keith Allen, Reader in Mining at the Royal School of Mines and a Past-President of the Institution of Mining and Metallurgy. Owing to the difficulties created by the recent dispute in the printing industry the MAGAZINE has been somewhat frustrated in its attempt to signalize its 50 years of service to the industry at the appropriate date, the first issue having appeared in September, 1909, but it is intended from now on to publish the series of special surveys that have been collected to mark the occasion. When the first MAGAZINE appeared it was described as a periodical " designed to be useful to mining engineers and metallurgists, to the managers and superintendents of mines all over the world, to managing directors at home, and to other persons having an intelligent interest in the industry of mining." Perhaps, in the event, it can claim to have succeeded in all that and to have done something more. As Dr. G. A. Schnellmann in the brief review of progress in mining geology he gave in the August and September issues pointed out there was 50 years ago scant recognition of the part geology was to play in mineral exploration and almost none of the role of the " mining geologist." To this new-fangled branch of the profession the MAGAZINE can claim to have provided excellent service, as indeed it did in drawing attention to the

potentialities of geophysical prospecting, while the growth of the importance of improved mineral-dressing techniques has been watched and recorded with equal interest. Thus it can be claimed that the aims of the founders of the MAGAZINE have well sustained and the interests of the industry served with a measure of success.

Rising labour costs, the increasing complexity of ores, the disappearance of outcrop ore-bodies, and a more and more rapid encroachment on the wilderness in the search for the metals modern science and engineering demand for their projects have led to the growth of mining units powerful enough to design and project their efforts on the mammoth scale. Low-grade material treated in vast quantities can, it has been found, yield the ready profits once only enjoyed by the fortunate able to exploit the bonanza occurrences which in these days seem so far away. It may be stated, however, that while change has been inevitable and the lone hand has given over to the company employee the calibre of the man who takes up mining engineering has changed hardly at all. While much of the romance may have gone from his calling a spirit of adventure and a capacity to endure are still his most marked characteristics, characteristics seldom damped by the necessity for increased technological skills. If the MAGAZINE has been of help to those men in the past, as it may well claim, it is certainly intended to continue its service in the future.

When the Rickards founded the MAGAZINE in 1909 it was as the result of a wish expressed by a group of well-known engineers in the City of London. "T.A." also became the Editor, arriving in this country to continue the career in technical journalism he had commenced with such distinction in the United States. We have been fortunate enough through the good offices of Mr. Donald Gill in obtaining a photograph of the Royal School of Mines dinner held in December, 1909, at which T. A. Rickard acted as chairman. This group, reproduced here, is remarkable in that many famous personalities and many who later reached eminence in the profession since are included. Professor W. A. Carlyle and Professor S. H. Cox are there, for example, as are Mr. Charles McDermid, secretary of the Institution of Mining and Metallurgy, Mr. A. G. Charleton, Mr. E. A. Wraight, and Mr. Edgar Taylor, as well as Mr. L. H. Cooke and Mr. W. H. Merrett, later professors of Surveying and Metallurgy respectively. Many others in attendance will no doubt be recognized. T. A. Rickard will be also remembered as the first Secretary of the Royal School of Mines (Old Students)

The Royal School of Mines Dinner, December, 1909.

Association, of which indeed he may be almost claimed as the founder. Mr. Gill's photograph, now to lie in the muniment room at the Imperial College, will perpetuate the memory of the first Editor of THE MINING MAGAZINE.

New Shaft-Sinking Record Claimed

By sinking 922 ft. in 30 days Vaal Reefs Exploration and Mining Company, a mine of the Anglo American Corporation group on the Far West Rand, broke the world's shaft-sinking record held, by Russia, on October 1. The Russian record of 868 ft. in one month, achieved in the Don coalfields, was announced on April 30 of this year, it is stated, and the new record is claimed to be all the more remarkable for the fact that the Vaal Reefs shaft has an excavated diameter of 26 ft. as compared with the Russian shaft's 21·65 ft. It was achieved during the second full month of regular sinking operations at the new shaft on the mine. The Vaal Reefs No. 2 shaft, where the record was broken, is a 26-ft. concrete-lined circular shaft with a planned depth of 7,200 ft. Excavation of the shaft collar started in May, 1958, and thereafter construction work on the collar and headgear occupied the period until July 2, 1959. By the end of August, 1959, the shaft had been sunk to a depth of 1,132 ft. and during the record month it was advanced to 2,054 ft. Precementation was carried out in advance of shaft sinking and 51,325 pockets of cement were used in sealing off the water-bearing dolomites, which extend to a depth of approximately 1,600 ft. The success of this technique was evidenced by the fact that comparatively little water was encountered during the record month.

Mineral Resources of Borneo

Recently available is the British Borneo Geological Survey Report for 1958,[1] in which Dr. F. W. Roe, the Director, gives his customary informative review of operations in the territories which include Sarawak, Brunei, and North Borneo. In a year otherwise marked by recession, he says, the economic results of past geological work provided a bright feature. A new industry, the mining of bauxite in Sarawak, was successfully launched, while prospecting for chromite was begun in North Borneo and exploration activities in all areas increased. At the same time geological mapping and research were not allowed to fall behind and some promising results are recorded.

[1] Kuching, Sarawak: Geological Survey Department.

In the year under review minerals exported were valued at $Malayan 349,300,000 [1] (£40,752,000), a figure which represents about 70% of the value of exports shipped. Revenue yield to the three Governments was $100,775,000 (£11,757,000). Describing the successful launching of Sarawak's bauxite industry the report says that initial mining and shipping difficulties at the new mine at Sematan were soon overcome. Ore produced totalled more than 136,000 tons, of which 99,930 tons, worth about $1,837,000 (£214,000), was exported. Prospecting gave encouraging results and arrangements were completed for increasing production and export this year.

The output of oil—Brunei's main money-earner—decreased slightly from the 1957 figure. Oil production for the year under review totalled 39,629,000 barrels, but Dr. Roe warns that if new sources are not found the decline is likely to continue. However, the oil companies show persistence in their search despite recent discouraging results. During 1958 exploration for new fields continued steadily, a mobile drilling barge having been used to aid the main effort, concentrated on the coastal region and the off-shore area of the continental shelf beneath the China Sea. Of more than $9,000,000 (£1,050,000) spent on the search for oil a considerable proportion was used in Sarawak, where the year's output was 410,395 barrels.

Tests are in hand on the chromite resources of the territories, as well as into the possibility of cement manufacture, glass-sand utilization, and the development of stone and gravel industries. At the same time geological mapping continued steadily in the year and two surveys were completed covering 7,100 sq. miles. In the Borneo territories such investigations involve exploration of remote, jungle-clad, sparsely-populated mountainous areas in tropical temperatures. Despite the difficulties of this slow and arduous work, however, areas covering 35,500 sq. miles have now been explored and described.

[1] The Malayan $ = 2s. 4d.

MONTHLY REVIEW

Introduction.—The result of the General Election, in which the Government has been returned with an increased majority, cannot but serve to maintain business confidence. Meanwhile the steel strike in the United States continues and base-metal prices are well sustained.

Transvaal.—The output of the Rand mines for August amounted to 1,699,098 oz., making with 36,052 oz. from outside mines a total of 1,735,150 oz. for the month. At the end of August there were 377,257 natives at work in the gold mines as compared with 381,190 at the end of July.

In the middle of September NEW CONSOLIDATED GOLD FIELDS announced that it had acquired mineral right options over approximately 60,000 morgen some distance south of the mines of the Far West Rand, extending from the Farm Doornpoort No. 347 in the east to the Mooi River in the west. It is intended to explore this ground with a view to establishing whether or not the reef horizons which have proved of economic importance on the "West Wits. line" to the north re-occur at mineable depths and drilling operations are to be started at an early date, it is stated.

Elsewhere in this issue reference is made to a new shaft-sinking record achieved at VAAL REEFS No. 2 shaft—a 26-ft. concrete-lined circular shaft with a planned depth of 7,200 ft. Concreting is being carried out concurrently with the sinking. The mix is spouted through a 6-in. column from the surface, while the shuttering which holds the concrete in position is controlled from the stage. The whole operation takes place in 20-ft. and 40-ft. lifts, depending on circumstances.

The report of LUIPAARDS VLEI for the year to June 30 last shows a profit of £1,151,310 and a total of £1,414,612 available, of which dividends totalling 2s. a share require £496,911. In the year 833,000 tons of ore from the Main Reef section was milled, yielding 145,228 oz. of gold, while 599,000 tons from the Bird Reef produced 17,950 oz. of gold and 759,614 lb. of uranium oxide. Ore reserves at June 30 last were estimated as 1,410,000 tons averaging 4·5 dwt. on the Main Reef and 1,002,000 tons on Bird Reef, giving 1·3 dwt. in gold and 1·86 lb. of uranium oxide per ton.

Following the annual meeting of NEW MODDERFONTEIN GOLD MINING held on October 15 it was to be proposed that the company should go into voluntary liquidation. The report for the year ended June 30 last states that as the whole of the company's realizable assets have now been disposed of the directors are of the opinion that the time is appropriate to place the company into liquidation and says that with a view to making a first and final liquidation distribution to shareholders at the earliest opportunity, it is proposed to discount the debt of £60,000.

Circulars to shareholders of MIDDLE WITWATERSRAND (WESTERN AREAS) and ROODERAND MAIN REEF MINES issued last month disclosed that the directors of Middle Wits. have entered into a conditional agreement to acquire approximately 87½% of the assets of Rooderand, the purchase consideration to be satisfied by the allotment of 840,448 Middle Wits. shares of 2s. 6d. each now in reserve. Rooderand is to reduce its share capital by a return of 6d., to be satisfied by the distribution of one FREDDIES CONSOLIDATED £1 share for every five Rooderand 5s. shares held.

At extraordinary meetings of BRAKPAN MINES and SPRINGS MINES to be held in Johannesburg on November 5 it is to be proposed that the 5s. shares of the two companies shall be reduced in value to 3d. by repayments up to 4s. 9d. per share as funds become in excess of need.

RAND LEASES (VOGELSTRUISFONTEIN) is to hold an extraordinary meeting on October 16 to consider a reduction in capital from £1,665,000 to £45,000 by reducing the value of the shares from 9s. 3d. to 3d. The 9s. repayment is to be made as funds become available.

With the recent dividend notice shareholders of RUSTENBURG PLATINUM MINES have been informed that the profit for the year to August 31 last amounts to £2,950,000. The notice says that there was a marked increase in sales in the year and notes that, while stocks of platinum held by the oil-refining companies appear to be sufficient for the current needs of that industry, there has been a measure of improvement in sales to other industries in the U.S.A. and U.K.

particularly in the export market to countries other than the U.S.A.

At the end of September the directors of NATAL COAL EXPLORATION announced that arrangements had been concluded with VEREENIGING ESTATES in terms of which that company subscribed on September 24 for 200,000 reserve shares of 5s. each in the capital of the company at a premium of 3s. 6d. per share—*i.e.*, a price of 8s. 6d. per share. This issue raised £85,000 new capital, enabling the company to repay its loan of £48,000 from Vereeniging Estates and to have available a balance of funds for future capital needs.

Diamonds.—Earlier this month DE BEERS CONSOLIDATED MINES announced that in the September quarter diamond sales through the Central Selling Organization on behalf of South African and other producers totalled £23,208,289, of which £16,891,253 is attributable to gem stones. At the end of September the De Beers directors announced that the ANGLO AMERICAN CORPORATION OF SOUTH AFRICA had exercised its right to convert the whole of the loan at present outstanding—namely, £4,200,000—into fully-paid deferred shares in De Beers at a price of 120s. per share.

Southern Rhodesia.—It was recently announced that RIO TINTO (SOUTHERN RHODESIA) had exercised its option to buy the entire shareholding of LESLIE GOLD MINES, LTD., of which ANMOR MINES AND MINERALS (PRIVATE), LTD, the owner of the Patchway mine, is a wholly-owned subsidiary. The Patchway gold mine, situated some 12 miles north of Gatooma, is milling at a rate of about 3,000 tons per month. Since July this year the mine has been operated on tribute by Rio Tinto, as in recent months investigations by RIO TINTO MINERAL SEARCH OF AFRICA have indicated possibilities for the expansion of the mine. Rio Tinto has also exercised its option to purchase the Big Ben gold mine, some seven miles to the east of the Patchway.

Adjacent to these two mines Rio Tinto has been granted an Exclusive Prospecting Order of approximately 24 sq. miles within which routine exploration work is being carried out.

Northern Rhodesia.—A preliminary statement issued by ROAN ANTELOPE COPPER MINES gives the profit for the year to June 30 last as £2,949,185. A final dividend of 7d. per share has been declared. Production of new copper for the year totalled 80,873 tons.

Ghana.—Earlier this month the ASHANTI GOLDFIELDS CORPORATION gave its profit for the year to September 30 as £1,574,984, a record figure which can be compared with £1,314,378 for the previous financial year. In the Ashanti mine recent developments have been consistently good, while new ore-bodies of payable value are being developed as high as 6 level and as low as 41 level; laterally, workable deposits are to be found as widely dispersed as 10,000 ft. from north to south. From the number of reef intersections reported in each of the past four monthly reports it is thought clear that full benefit is now being derived from the Eaton-Turner shaft, which has made available what is virtually a new mine between 32 and 41 levels. Equally high values have been reported in the new section of the mine now being opened up below the old Ayeinm workings, formerly regarded as a low-grade section.

The accounts of the KWAHU MINING CO. (1925) for the year ended June 30 last show a profit of £48,047 and £56,148 available. A dividend equal to 30% requires £20,379 of this amount and after making other allowances a balance of £9,430 is carried forward.

Tanganyika.—Shareholders of the TANGANYIKA DIAMOND AND GOLD DEVELOPMENT COMPANY have been informed that in the June quarter 72,383 loads of ground were treated at the Alamasi mine and 4,497 carats of diamond recovered.

Australia.—With the recent dividend notice shareholders of MOUNT ISA MINES were informed that the consolidated profit for the year ended June 30, 1959, is £A4,030,722, after providing £A197,005 for Income Tax, £A1,896,250 for provision for Income Tax equalization, and £A1,247,774 for depreciation. The directors have appropriated from the profits of Mount Isa Mines for the year £A1,900,000 for capital expenditure and development.

A preliminary statement by NORTH BROKEN HILL gives the profit for the year ended June 30 last as £517,000. After adding investment income of £603,000, less relative provision for taxation (£4,000), the surplus for the year carried to the appropriation account was £1,116,000. In the appropriation account there is a credit of £181,000, being the sum unexpended out of the 1958 appropriation for new plant and development; £370,000 has been appropriated for expenditure during the current year.

New Zealand.—The operations of CLUTHA

River Gold Dredging in the year to March 31 last resulted in a profit of £4,110, the accounts showing £8,616 available. A dividend equal to 5% requires £5,104 of this amount. In the year 3,207,000 cu. yd. of ground was treated and 5,521 oz. of bullion recovered. The report says that the dredge reached Block 5 in July and suggests that, judging by the boring results, this area should produce better returns than those experienced over the last few years. The output for the current year up to September 11 amounted to 3,292 oz. as compared with 2,349 oz. for the same period in the previous year.

Malaya.—In his statement to shareholders of Tronoh Mines, Ltd., the chairman, Mr. J. H. Rich, says that the company had continued its search for new areas but was hampered by the lack of a national land policy. It is hoped the position will improve if the Government of the Federation finds it possible to adopt at an early date the recommendations of the Land Commission which it appointed. It was gratifying to note, the chairman said, that the Federation Government had lost little time in adopting one of the recommendations by setting up a National Land Council to formulate with the State Governments a co-ordinated land policy. The prospecting done so far indicated that the most hopeful results were located in Thailand.

In the year to March 31 last Southern Kinta Consolidated produced 3,280 tons of tin concentrates, operations resulting in a profit of £353,458. The accounts show £769,692 available, of which dividends totalling 85% require £391,294.

Last month the directors of Pengkalen, Ltd., announced that they had decided to recommend that the issued capital of the company should be increased by the capitalization of part of the general reserves. The company's issued capital is now £32,000 and it will be, if the proposals are approved by members, £160,000. Four new shares of 1s. each will be allotted for each share of 1s. held.

Sungei Besi Mines announced recently that it had revised the offer to acquire all the shares of Hong Fatt (Sungei Besi), the basis of the new offer being a cash payment of $1·50 *plus* one Sungei Besi share of 4s. for every five Hong Fatt shares of $1 held.

India.—At the annual meeting of the Indian Copper Corporation last month the chairman, Mr. P. E. G. W. Parish, said that the project for the manufacture of electrolytic copper was going ahead. Negotiations had reached an advanced stage and application had been made to Government for the release of the necessary foreign exchange. As matters now stood they were waiting for final approval, on receipt of which the whole project was to be put in hand. A considerable sum of money, amounting to approximately £700,000, would be required to finance the scheme, but it was expected that that could be provided within the company's own resources.

Burma.—Early this month it was announced that the directors of the Anglo-Burma Tin Company had asked the Anglo-French Exploration Company not to make its intended bid of 4s. 6d. a share. This, it is stated, has been agreed to, but Anglo-French is to continue to accept any Anglo-Burma shares offered at 4s. 6d. until further notice. It is stated that the Anglo-Burma resources have been fully invested in mining securities and this should enable a small dividend to be paid for the current financial year. Net assets, including investments at market prices, are put at 4s. 5d. a share. Meanwhile it is not considered possible to determine the value of the company's holding in Anglo-Burma Tin (1956), the operating company shared with the Burma Government.

Portugal.—At the extraordinary meeting of Mason and Barry held last month the resolutions recommending the capitalization of reserves, issuing of shares, and increase in the authorized capital were unanimously approved. It was stated that in connexion with the hope to establish alternative industry at Mina de S. Domingos they had been sending to those interested a small brochure outlining the activities of the company and the available facilities at Mina de S. Domingos. They proposed to circulate in due course a somewhat similar brochure to shareholders.

United Kingdom.—It was announced last month that crude oil production from BP Exploration Company's English oilfields totalled 39,827 tons in the first half of 1959. This compared with a production of 40,101 tons in the first six months of 1958. The main producing fields are at Eakring and Egmanton (Notts.) and Plungar (Leics.).

In the year to March 31 last Geevor Tin Mines milled 63,484 tons of ore and recovered 683 tons of black tin. Operations resulted in a profit of £74,534. The accounts show £89,731 available, of which dividends and

a bonus totalling 3s. a share require £37,539. Ore reserves are given as 202,542 tons.

The directors of the SOUTH DURHAM STEEL AND IRON COMPANY announced last month that the Finance Corporation for Industry, pursuant to its agreement with the company, had elected to exercise its option to convert £2,000,000 nominal amount of its outstanding loan into ordinary shares at par. The company had accordingly agreed to issue 2,000,000 ordinary shares of £1 each on October 1, such shares to rank in all respects equally with the issued ordinary shares.

British and Rhodesian Discount House.—The British and Rhodesian Discount House, Ltd., was registered last month with an authorized capital of £250,000, of which £125,000 is to be issued and paid up. The company is sponsored by the ANGLO AMERICAN CORPORATION OF SOUTH AFRICA and SMITH ST. AUBYN AND CO., LTD., a member of the London Discount Market Association. Other important banking and financial institutions in Rhodesia and Great Britain are associated with the new company, it is stated. This development of the money market is in accordance, it is suggested, with the principles proposed by the Federal Government and the banking authorities in the Banking Act, 1959, which defines and controls all aspects of banking business conducted in the Federation by banks, accepting and discount houses, and other financial institutions. The Act has been passed by the Federal Assembly.

North Charterland Exploration Co. (1937).—At the annual meeting of the North Charterland Exploration Co. (1937), Ltd., held in Salisbury, Southern Rhodesia, last month the chairman said that prospecting operations on the company's mineral concession in Northern Rhodesia had been continued by the ANGLO-VAAL CHARTERLAND EXPLORATION COMPANY and prospecting revenue had increased owing to the terms of the prospecting agreement. The agreement had a further three years still to run and it was hoped that during that time some satisfactory results might be obtained. The general overall plan of prospecting campaign is continuing.

Tanganyika Concessions.—With the recent dividend notice shareholders of Tanganyika Concessions, Ltd., were informed that the profit for the year to July 31 last, subject to final audit, was £3,293,993, subject to taxation. A final dividend equal to 2s. 3d. a share is proposed.

DIVIDENDS DECLARED

* Interim † Final

(Less Tax unless otherwise stated).

***African and European Investment Co.**—1s., payable Nov. 12.

***Anglo American Corporation of South Africa.**—2s., payable Nov. 12.

†**Blinkpoort Gold Syndicate.**—2s. 4½d., payable Nov. 6.

†**Broken Hill South.**—5d. (Aust.), payable, Dec. 3.

†**Clutha River Gold Dredging.**—5%.

***Consolidated Tin Smelters.**—Pref. 3½%, payable Nov. 14.

***De Beers Consolidated Mines.**—5s., payable Nov. 2.

†**Free State Geduld Mines.**—4s. 6d., payable Nov. 5.

†**Harmony Gold Mining Co.**—1s. 3d., payable Nov. 5.

***Henderson's Transvaal Estates.**—4d., payable Nov. 19.

***Kinta Tin Mines.**—3d., payable Oct. 22.

†**Kwahu Mining Co. (1925)**.—30%.

†**Lydenburg Platinum.**—10d., payable Nov. 5.

†**Mount Isa Mines.**—9d. (Aust.), payable Dec. 31.

†**Ndola Copper Refineries.**—3⅔%, payable Dec. 19.

†**Potgietersrust Platinums.**—9d., payable Nov. 5.

†**President Brand Gold Mining Co.**—3s., payable Nov. 5.

†**President Steyn Gold Mining Co.**—1s. 3d., payable Nov. 5.

†**Roan Antelope Copper Mines.**—7d., payable Dec. 19.

†**Rustenburg Platinum Mines.**—26s. 3d., payable Oct. 9.

***St. Helena Gold Mines.**—1s. 9d., payable Nov. 5.

†**South African Torbanite Mining and Refining.**—7½d.

†**Tanganyika Concessions.**—2s. 3d., payable Jan. 29.

†**Union Platinum Mining Co.**—1s. 1¾d., payable Nov. 5.

†**Waterval (Rustenburg) Platinum.**—1s. 3d., payable Nov. 5.

†**Welkom Gold Mining Co.**—3d., payable Nov. 5.

†**Western Holdings.**—5s., payable Nov. 5.

†**Yarra Falls.**—4%, payable Oct. 20.

METAL PRICES

October 9.

Aluminium, Antimony, and Nickel per long ton; Chromium per lb.; Platinium per standard oz.; Gold and Silver per fine oz.; Wolfram per unit.

	£	*s.*	*d.*
Aluminium (Home)	180	0	0
Antimony (Eng. 99%)	190	0	0
Chromium (98–99%)		7	2
Nickel (Home)	600	0	0
Platinum (Refined)	28	10	4½
Silver		6	7½
Gold	12	10	7¾
Wolfram (U.K.)		—	
(World)	6	10	0

Tin, Copper, Lead, Zinc } See Table, p. 200

A Half Century of Progress in Metal Mining—I

G. Keith Allen, B.M.E., M.I.M.M.*

The first part of a critical survey

Introduction

The pattern of metalliferous mining has, in the nature of things, changed considerably in the past 50 years; 1909 belonged to the era of the traditional prospector, to the days of pioneering, to the small rich mine yielding quick profits to the lucky investors, and to the individualist mining engineer. Nowadays the prospector has been superseded largely by the mining geologist and the geophysicist, modern methods of transport and communication have taken the sting out of pioneering, rich mines are fewer and harder to find, and mining groups of specialists have to a great extent replaced the independent engineer.

Times and methods have changed and the underlying incentive is the ever-increasing demand for metals. As more than one authority has recorded more metals and minerals have been mined in the last half-century than in all previous history. As an indication of this growth statistics show, for example, that since 1909 gold production has risen about 1·7 times, copper 4·0, lead 2·3, and zinc 3·0 times. The output of aluminium, which 50 years ago was reckoned in pounds, is now some 4 million tons per annum, and the mining of uranium ore, then on a small scale mainly for the production of radium, is to-day at the rate of millions of tons per year, to supply the needs of the atomic energy industry.

Although many new mines have naturally come into being, it is mainly by the application of improved techniques to existing basic methods of mining that this great demand has been met. The replacement of manual labour by machines, better materials such as drill steel, bits, and explosives, a greater understanding of rock mechanics and problems of support, and better planning and management have contributed most to the progress of the industry. The result has been a great increase in labour productivity, much larger scales of operation, and a lowering of the grade of ore profitable to mine, despite higher wages and shorter working hours. Coincidently, the capital cost of bringing mines to the production stage has steadily risen, not only for plant and machinery, but also for the provision of houses, hospitals and other welfare amenities for employees. The cost of equipping a mining property has risen by something of the order of four to five times since 1909, after making allowance for the depreciated value of money since then.

The increasing cost of developing and equipping mines, combined with that of search for new deposits to replace those being exhausted, accelerated the growth of large mining groups for the provision of money and technical services for such ventures. This type of development has been a notable feature of the metal-mining industry in the last 50 years and is a natural consequence of the increasing complexity of mining, which embraces not only the extraction of ores and their metals, but also the sale of the products.

The period under review is also notable for a greater awareness of the importance of the individual in industry, of greater interest in his welfare and safety, and of his training and suitability for the work he is required to perform. There has become a greater recognition that on him depends largely the efficiency and prosperity of an enterprise, whether he be workman or official.

In the technical sphere probably the greatest single advance has been in the application of electricity to mining machinery, followed closely by that of compressed air. In 1909 these applications were in their infancy. Mechanization has not only increased productivity, it has also had its effect on the nature of labour employed in mining. Whereas 50 years ago the miner exercised his traditional skills, handed down from father to son, of drilling, loading, and transporting the ore he won by his own exertions, he is

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gradually being superseded by the trained operator of machines designed to perform such work more effectively and efficiently than ever before. But the manual worker will never be entirely replaced, and in fields where wages are low, or where operations are on a small scale, he is still much in evidence—even there the trend is towards more mechanization. Examples of this are the application in recent years of the mechanical grab to shaft sinking in South Africa and the now almost universal use of drilling machines in even the remotest and smallest of mines.

The increase in mechanization has led naturally to automatic control of machines, especially in operations of a repetitive nature—such as, hoisting, haulage, pumping, and ventilation. Control is effected by mechanical, pneumatic, or hydraulic means, which may be combined with electronic systems. Closed-circuit television, photo-electric cells, limit and proximity switches, and other monitoring devices in interlocking circuits result in labour saving and more accurate and positive control.

Progress in recent years is also notable for great activity in research into the fundamental problems of mining—such as, drilling, blasting, and ground support. In all the important mineral-producing countries of the world universities, schools of mines, Government-sponsored establishments, equipment manufacturers, and mining companies are busily engaged in this direction and mining is rapidly becoming less an art and more applied science than ever before.

In the sphere of management control computers and mechanical accounting machines have replaced the old laborious methods of accounting, costing, store keeping, and other statistical work in most large mining organizations.

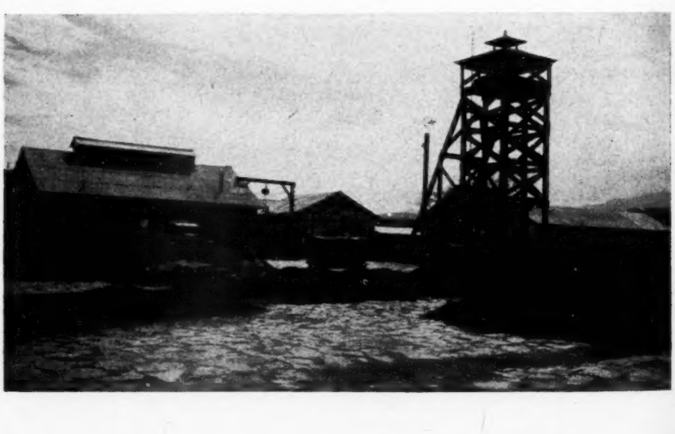
These, then, outline the main advances in the metal-mining industry during the last 50 years and progress in the various branches will be examined in more detail in the following.

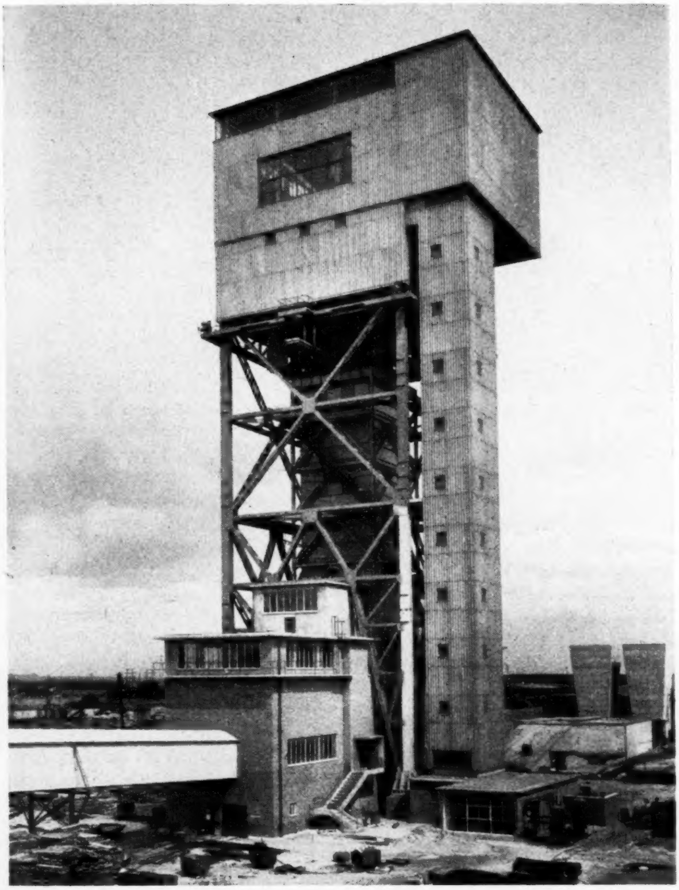
Explosives

Notwithstanding the fact that atomic explosives may yet spell disaster to the human race, conventional high explosives are the life blood of modern civilization. Without them could never be achieved the high production of metals upon which our very existence depends to-day.

The origin of high explosives for mining goes back to 1846 when Sobrero, an Italian chemist, discovered nitroglycerine. It was not, however, until 1866 and later, when Nobel produced dynamite and gelatine, that high explosives were made amenable for the use of man. Originally dynamite was a mixture of nitroglycerine and kieselguhr, but in modern types the latter is replaced by wood pulp or other inert combustible material with the addition of sodium and ammonium nitrates. The strength of dynamite is rated by its nitroglycerine content. Blasting gelatine is a combination of nitroglycerine and gun cotton, but is too powerful for most purposes. It is graded down with wood pulp to form gelatine or gelatine dynamite. At temperatures between 40° C. and 45° C. nitroglycerine freezes and in this condition is extremely sensitive. Chambers, heated by hot water pipes, were commonly used to thaw explosives, though one authority writing in 1910 recommended burial in manure heaps as the

Old Headgear at a Mexican Silver Mine.





Modern Headgear at a British Colliery.

safest method ! An important advance was made when it was discovered that the substitution of a proportion of the glycerine by glycol before nitration lowered the freezing point to well below zero. This gave rise to the so-called " Polar " explosives.

Dynamites are granular in texture, while gelatines are plastic. Ammonium nitrate mixed with a small amount of nitroglycerine and with wood pulp is the basis of various explosives, mostly employed in quarry work. An important recent development is the use of ordinary commercial ammonium nitrate mixed on site with diesel oil or other similar hydrocarbon and detonated in the usual way. In blast-hole open-cast mining it is proving effective and cheaper than the dynamites previously used. It is also being used in underground blasting with some success.

Gunpowder, or black powder, is still used in open-pit mining for blasting soft or weak rocks where a heaving or rending action is desired, rather than the quick action of high explosives. Its speed of detonation depends on the grain size ; the finer this the faster the detonation.

Liquid oxygen explosive (L.O.X.) consists of powdered charcoal soaked in liquid oxygen. It was first used about 1915, but although it has received extensive trials since, is now rarely used in metal mines. Its major drawback is the shortness of its life, owing to the quick evaporation of the oxygen.

The mercury fulminate detonator was invented by Nobel in 1864. It was the only type in use until 1908, when the lead azide detonator was first introduced. Although the

fulminate detonator remained the standard for many years afterwards, by 1935 it was rapidly being replaced by the lead azide and is now practically obsolete in metal mining. Lead azide detonators are safer to handle and less susceptible to moisture.

" Miners safety fuse " was invented in 1831 by Bickford and except for improvements in quality has changed little since then. In underground metal-mining practice it is still extensively used but in open-cast work it has for several years past been largely replaced by detonating fuse.

Detonating fuse was known in the early 1890's, and in 1907 Cordeau was put on the market. It consisted of TNT in a thin lead sheath and had a rate of detonation of 17,000 ft. per second. Since then, under various trade names such as Cordtex or Primacord, other varieties have been introduced which have a textile covering and a rate of detonation of about 20,000 ft. per second. Its main application is in long-hole blasting, in which a line of the fuse throughout the length of the hole ensures complete detonation of the contained explosive. By its use, also, any number of holes can be blasted simultaneously by branch lines connected to a main trunk line. Detonation of the fuse is initiated by an ordinary capped fuse or by an electric detonator.

The first electric detonator was introduced in 1881 and delay detonators about 1911. The modern gasless type came into use in 1938, with delays of 1 second, later reduced to $\frac{1}{2}$ second. The short delay variety with 25 milliseconds delays, developed since 1946, gives less surface vibration. Better fragmentation also results in many cases.

A rival to electric delay detonators is igniter cord, which through a special connector will ignite safety fuse. Two varieties are available, one burning at the rate of $\frac{1}{10}$ ft. per second and the other at 1 ft. per second. By connecting capped fuses, each of the same length, to the trunk igniter cord in the appropriate order shots can be fired in timed sequence with one lighting of the igniter cord. The method is finding wide application in both development headings and stopes underground.

The loading of long holes in ring blasting, cartridge by cartridge, is time consuming and a method to speed up the operation was developed a few years ago in Sewden. A brass or copper tube of suitable diameter is filled with the cartridges which are pressed into the drill hole by compressed air. A cutter at the mouth of the tube slits the paper wrapping so that the explosive can expand to the full diameter of the hole. Although used widely in Sweden, it has not yet received much acceptance elsewhere.

In the past 50 years the quality, stability, and reliability of high explosives have greatly improved, though basically they have changed little. The greatest advances have been the development of the non-freezing varieties, of delay electric detonators, igniter cord, and recently the ammonium nitrate-fuel oil mixtures.

Surface Mining

This may be divided into alluvial and open-cast mining :—

Alluvial Mining.—The working of alluvials or placers is in most respects the simplest form of mining. The methods employed depend upon the occurrence of the deposits ; those in the form of terraces on high ground are mined by pick and shovel, or by sluicing with jets of water (hydraulicking), those in river beds or low-lying ground by dredging. The principal economic minerals are usually gold or tin (cassiterite).

Hydraulicking.—This method originated in California in the middle of the 19th Century and in practice has changed probably less than any other mining method since then. Powerful jets of water issuing from nozzles, known as Giants or Monitors, are used to break down the deposit, the resulting stream of " gravel " and water being directed through sluices in which the heavy minerals are caught behind riffles. Improvements have been made in recovery of mineral in the course of years, but the only notable change in mining practice is a recent (1954) development which enables one man to operate several nozzles by remote control.

This method of breaking up ground and transporting it by water is sometimes used, when conditions are suitable, for the removal of overburden in open-cast mines, but of greater interest is its comparatively recent application in underground mining. Underground hydraulicking is believed to have been in use since 1940 in Russian coal mines, where it has been highly developed. It is receiving some attention in the United Kingdom and the U.S.A. In Utah, a hydrocarbon mineral, gilsonite, is being mined by jets of water at 2,000 lb./sq. in. from a $\frac{1}{4}$ in. nozzle and the fine slurry pumped to the surface by centrifugal pumps.

Dredging.—Dredges are used for mining

Cleaning up a Sluice Box Early in the Century.

placer deposits in rivers and low-lying terraces mostly for the recovery of gold and tin. They constitute complete mining and mineral extraction units in themselves. The first of the modern type was built in California at the turn of the century. It had a close-coupled bucket excavator and belt-conveyor stacker and eventually made the earlier New Zealand type, with open-coupled buckets and pan conveyor stacker, obsolete. Hulls were almost invariably of wood, but by 1912 the present practice of steel construction was being adopted in the new dredges, though in northern climates, where wooden hulls deteriorate slowly, wood is still used.

One of the earliest problems associated with steel hulls, which does not appear to have been satisfactorily solved yet, is corrosion at the water line. The first steel hulls were built from steel plates riveted together on site, but later the pontoon and bolted water-tight compartment types were widely adopted. These are practically unsinkable and have the added advantage that they can be easily and cheaply dismantled and reassembled at other sites. Heavy dredge parts sometimes have to be sectionalized to meet transport requirements. A notable example of this is the Bulolo dredges in New Guinea, all the parts of which were transported by air a distance of some 50 miles over mountainous country.

Steam was the source of power for the early dredges, but by 1909 electricity was beginning to take its place and to-day has almost supplanted it entirely in new dredges. In special circumstances diesel engines have been used.

Fifty years ago digging depths rarely exceeded 60 ft. below water level or capacities 300,000 cu. yd. per month, as compared with 130 ft. and 500,000 cu. yd. of the largest dredges of to-day.

Mineral-saving equipment has undergone several changes, particularly in connexion with attempts to save more of the fine particles. Apart from modifications on the riffle tables used in the original dredges, classifiers, jigs, ball-mills, and flotation units have been incorporated in flow-sheets. Improvements in this section of the plant have increased not only the recovery but also the throughputs.

Open-Cast Mining.—In all but the smallest of workings, open-cast mining to-day is a highly mechanized operation and the same could be said of 1909 when compared with underground mining of that time. Power shovels, mechanized transport, and blast-hole drills constitute the main items of equipment and the changes in mining practice are related to the improvements made in the design and in the application of such machines, not to any change in principle.

The layout of an open-cast mine is determined by the shape and size of the ore-body. Steeply dipping deposits are worked by means of benches which may spiral around the pit, or may be connected by switchbacks, or by an incline down the face of the pit, serving each bench in turn. Alternatively, the benches may be connected by tunnels to a shaft sunk a safe distance from the workings or, where the topography is suitable, by adits to the rock disposal points.

In some cases the ore may be broken directly into passes known as "mill holes"

or " glory holes," which connect to loading chutes in a tunnel below. The method leads to dangerous working conditions around the hole and, since the great development in the last few years of rock loading and transport machines, has become out of date. The term " glory hole " is thought to have originated from the large number of deaths caused by miners falling down these holes, the victims being spoken of as having gone to " Glory."

Shallow flat-dipping deposits may often be mined without benches, depending on the overburden, and the ore-body. Benches in ore are rarely more than 60 ft. high, but in overburden have been carried well over 100 ft. when the ground is suitable for digging by the largest of modern draglines.

In the early days of open-cast mining a ratio of overburden to ore of more than 1:1 by volume was considered uneconomic. With modern equipment a ratio of 3:1 is now not uncommon, and in some instances may reach 7:1, depending on the grade of ore.

Open-Cast Equipment

Shovel Excavators.—The first mechanical shovels were steam driven and built in America about 1865 for railroad and similar works. Although used for stripping overburden in the anthracite regions of Pennsylvania by 1887, it was not until the 1890's that they were introduced for metal mining in the iron-ore mines of Minnesota and Michigan.

The early shovels used in this type of work were of the railroad type, on rails and limited in swing to about $\frac{3}{4}$ of a circle. This meant they could load only alongside the machine. The first full-revolving type was

Scaling Back the Overburden in an Early Malayan Open Pit.

Modern Overburden Stacker.

made in England by Wittaker in 1884, quickly followed a year later by Thew in America. The advantages of being able to load all around the machine were soon recognized and by 1909 full-revolving shovels were widely employed in open-cast metal mines.

About this time electricity made its appearance for driving shovels, but progress was slow. It is reported that by 1914 only about 20 electrically powered shovels were in existence. Among the first to use them were the magnetite mines at Kiruna, Sweden, to where eight were shipped from America between 1914 and 1916. In those years, internal combustion engines, petrol and diesel, were also first fitted to shovels.

Steam shovels may still be found at work in open-cast mines, but they are comparativey rare now ; diesel or diesel-electric units, or electricity supplied by cable from an outside source have taken its place. For small shovels, especially those used in underground mining and tunnelling, compressed air is also a common alternative.

About 1911 a major development was the adoption of caterpillar tracks. They exert low bearing pressures (of the order of 1 ton per sq. ft.) on the ground and are thus particularly suitable for open-cast work where the surface is liable to be soft from rain or snow. This type of mounting is now almost universally used for large shovels in open-cast mining.

For smaller shovels rubber-tyred wheels are frequently fitted, more commonly on machines for underground than surface mining.

The trend in design is constantly towards machines of larger capacity. Fifty years ago the largest full-revolving shovels were fitted with buckets of some 3½ cu. yd. capacity ; today 10 cu. yd. would not be considered unusual. Much larger machines than this are working, usually for overburden removal, and monsters with 70 cu. yd. buckets have been constructed. One of these machines with one operator and a mechanic can handle over 7,000 tons of overburden per hour. The total installed horsepower is about 12,000, and its cost nearly £1,000,000.

Bucket-Wheel Excavators.—These consist essentially of a series of buckets mounted on the circumference of a power driven wheel, which discharge on to a conveyor built into the machine. They are a comparatively recent development, having originated in Germany for use in its brown coal open-cast mines. Their field of use is in easy digging material, and they have a high output for their weight and cost. One of these machines, having a wheel diameter of 20 ft. 4 in. with eight buckets of 0·45 cu. yd. capacity each, has been installed recently at Nchanga copper mine in Northern Rhodesia for the removal of overburden. It will dig an 86 ft. high face and at maximum speed has an overall capacity of over 1,800 tons per hour. An even larger machine, with a 52½ ft. diameter wheel and eight 4½ cu. yd. buckets is operating in Germany.

Draglines.—These work on the principle

of the scraper and, in fact, the first was developed from the horse drawn scraper about 1904. The early models suffered from the disadvantages of limited swing and went through a similar process of evolution to the excavator shovel. By 1909 full-revolving draglines were in use and rapidly proved their worth for stripping overburden in ground soft enough to be dug without prior loosening. Compared with the other types they have the great advantage of being able to dig well below the level of the machine and, in fact, this is their main function.

The size and capacity of draglines has also increased greatly in the last 50 years, and models with 12 cu. ft. buckets that will dig to depths of well over 100 ft. are not unusual. A few with buckets of 25 cu. yds. and even larger have also been constructed and have been in use for several years.

Draglines can load over a much greater area from one position than excavator shovels and hence need not be so mobile. Although caterpillar tracks are usually fitted to the medium-sized machines, large draglines are now mounted on two pontoons, one on each side, which lift and move the machine backwards or forwards by power operated cams. The action resembles walking and the machine is known as the Walking Dragline. The first of this type was built in the early 1930's.

Finger-tip control and air-conditioned driving cabs are usual with these large machines. These features have done much to improve output.

Scraper Loader.—This machine, which is a combined earth scraper and transporting unit, linked to a tractor, was developed in the 1930's. Normally the tractors are diesel powered and fitted with crawlers or rubber-tyred wheels; the latest development is a diesel-electric unit with all-electric drive, d.c. motors being fitted in each wheel. One of these recent machines has eight 150-h.p. electric wheels and can scrape and transport a load of 130 tons.

Scraper loaders have wide application for stripping overburden. They can haul loads up steep gradients and over soft ground and in such conditions offer probably the cheapest method of moving large quantities of earth and rock.

Bulldozers.—This is one of the most ubiquitous of machines; no open-cast mine would be fully equipped without one. It was developed many years ago and consists essentially of a scraper blade attached to the front end of a tractor. When the blade is fitted at an angle to the line of approach it is known as an angle dozer. It is a most useful labour-saving device, and is used for such jobs as levelling and grading roads and benches, cleaning up after shovels, building dumps, and pushing broken rock into passes or chutes. Usually the tractors are crawler mounted, but recently more rubber-tyred models are being produced.

Diesel Trucks.—These range in size normally from a few tons capacity up to 75 tons, but for use in special circumstances larger sizes have been built. Trucks are self-dumping, either sideways, to the rear, or bottom dumping. They permit a considerable flexibility of working, which is an important factor if isolated sections have to be mined, or selective mining is necessary. They eliminate the laying of tracks and can negotiate steep grades (up to about 15%) and sharper bends than rail vehicles. They thus shorten the haul and lessen the amount of roadways necessary. On the other hand, maintenance costs are high and a well-organized maintenance department is essential for their efficient and economical operation.

In the larger-sized vehicles power steering, power-operated brakes, automatic transmission, and torque converters are common features of their construction. The most recent development towards simplified power transmission is the all-wheel electric drive as mentioned previously under "Scraper Loader."

The largest diesel truck so far built is the Evenick, used for transporting overburden at the Bingham pit, in Utah. It is a huge 18-wheeled end-dump truck with two 430-h.p. diesel engines. It can carry 110 cu. yd. of heaped rock and used in conjunction with 50-ton Euclid trucks, and loaded by two 13 cu. yd. Marion shovels, 2,000 cu. yd. of waste per hour are being moved.

Strings of self-dumping trailers, drawn by a crawler-mounted tractor, are coming into favour in open-cast mining. Trailers up to 80 tons capacity are being used. The system results in an increase in load for a given horsepower and in suitable circumstances has effected appreciable lowering of transport costs.

Electric Trucks.—Trolley-line self-dumping trucks, in which the normal diesel engine is replaced by an electric motor, have been used successfully in recent years in at least one application. At the Crestmore limestone

Dragline at Work.

property in California 16 cu. yd. end-dump diesel trucks were converted in this way and have proved more economical than diesel truck haulage. Hauling from underground workings on the 440 level to the surface up a grade of 10% for a run of $1\frac{1}{4}$ miles, they carry almost 50% more rock in about half the time taken by diesels and at lower cost. For operating away from the line a cable reel is incorporated.

Conveyors.—Belts originally were made of rubber-coated cotton fabric, but though this type is still greatly used in industry several changes in construction have taken place in the course of years which are of importance in mining. They are all designed to give longer belt life and to increase the distance and height material can be conveyed by a single belt. The first improvement was the inclusion of wire strands running lengthwise and a later development on the same lines was substitution of a thin, high-tensile steel band, the full width of the belt, for the wires. This is the steel-band conveyor, which originated in Sweden.

The chain or cable conveyor represents another advance. Two chains, or steel cables, one on each side, support the belt and at the same time transmit the driving force. Also, in place of cotton, man-made fibres—such as Nylon and Terylene, are now being used in some belts.

Whereas originally conveyor-belts had a limited and localized field of use in mining, installations are now conveying ore from the working bench direct to the treatment plant which may be a matter of miles distant.

Aerial Ropeways.—These were in use well before the beginning of the century and in general have changed little. There are two principal types, one in which a single rope both supports the travelling bucket and pulls it from one end of the system to the other, and the second in which there are two ropes, one for each function. In some cases the system is self-acting, in that the full buckets on a down grade pull the empties on their return. For long hauls aerial ropeways are a cheap means of transport and in hilly country are frequently the only practical method.

Hydraulic Transport.—Moving finely ground ore mixed with water by pumping is, of course, normal in milling practice, but until recently transporting coarsely crushed ore has received little attention. Research and experiments in this direction are being conducted in several countries, but so far with only limited success. Its most promising field seems to be in the transportation of coal and other hydrocarbon minerals and it is of interest to note that in Utah gilsonite, after being mined hydraulically underground, is pumped with water out of the mine 72 miles to a refinery, crossing a 3,000–ft. mountain pass on the way. The wet gilsonite is screened underground, the *minus* $\frac{3}{4}$-in. material being transported in this way. Whether the method will ever prove economical for the heavier mineral ores seems, however, problematical at present.

Breaking Ground: Open-Cast

Drills.—In 1909 piston drills and churn drills were used for blast-hole drilling in open-cast mines. Piston drills were eventually superseded by the pneumatic hammer drill, developed for tunnelling, and churn drills, originally hand-operated, followed the designs of those used for oil-well drilling. Both types are still extensively used, the hammer drill mostly for the harder rocks and the churn drill for the softer. In recent years, however, there has been a tendency for rotary drills to replace churn drills in the less abrasive formations. Normally holes not more than 7 in. in diameter are drilled with the percussive machines, but up to 9 in. or more are not uncommon with churn and rotary drills.

There have been many advances in design of rock-drills in the last decade, too many to describe in detail here. There is the down-the-hole unit, in which the hammer drill is mounted next to the bit at the bottom of the hole; the rotary percussive drill, a combination of rotary and percussive action, and the turbo drill. The latter was developed for deep hole drilling in the oil industry and is operated at the bottom of the hole by the drilling fluid. It is not yet being used for blast-hole drilling. A combination drill which embodies three separate methods of drilling, normal percussive, down-the-hole percussive, or rotary, is finding useful application where ground conditions vary.

There are many varieties of bits, depending on the type of rock to be drilled and method of drilling. Percussive drills are usually fitted with tungsten carbide insert bits, which have a longer life and drill faster in hard rocks than the former hardened-steel bits. Bits for rotary drills are mainly of the three finger or the tricone type, which, like the drills, were originally designed for oil-well drilling. Tungsten carbide inserts may also be employed. In soft ground the auger finds an application, especially for short flat holes, but the diamond drill is rarely used for open-cast blast holes, despite its use for longhole drilling underground. Air rather than water flushing is practically universal for rotary blast-hole drills.

Since blast-hole drills are required to drill relatively shallow holes (seldom more than 75 ft. in depth) close together, they are usually mobile units mounted on skids, wheels, or crawlers. The larger sizes are generally self-propelling, driven by diesel or electric power. Percussive machines, when mounted on wheels, are known as "wagon drills"; where the terrain is rough the tendency is to use a crawler mounting. These machines can drill holes aligned at any angle, which is an advantage they have over the churn and rotary drill. Percussive drills are now sometimes remotely controlled, mounted on the end of an adjustable boom, an arrangement which allows face and "toe holes" to be drilled in a high bench with lessened danger to the operator from falling ground.

Jet Piercing.—Among the earliest techniques of breaking rock was "fire setting"—*i.e.*, heating and quenching with water. A method of penetrating rock by exactly this principle has been developed during the last few years, originally for getting blast holes into the hard, low-grade taconite iron ores of the Mesabi Range. It is known as jet piercing. To develop the jet a liquid hydrocarbon such as paraffin oil (kerosene) is combined with pure oxygen, both under pressure of about 250 lb./sq. in., inside a chamber, the burning gases issuing as a jet at a temperature of over 4,000° C. Water is used both for cooling the burner and for quenching the melted rock. Small models have been developed for blockholing and for cutting and shaping stone to finished dimensions in stone quarries.

Blasting.—Normal practice in blast-hole drilling is to drill one or more rows of vertical or slightly inclined holes parallel to the face of the bench. The holes in each row are staggered in relation to those in the next and with the largest-sized holes, which permit large explosive charges, a burden as great as 30 ft. may be put on each hole, with a spacing of 25 ft. The practice of "springing", to enable larger charges being loaded, was more common when drills capable of drilling large-diameter holes were less available than they are to-day. Large holes with large burdens tend, however, to produce large boulders in the break and thus increase the amount of secondary blasting required. As a result there has been a trend in recent times towards smaller-sized holes and lower benches, despite the fact that bench height is largely determined by the reach of the shovels.

Bench holes are drilled either a few feet in depth below the bench floor or stop short of that level and are supplemented by flat holes, called "toe holes," at bench level. The former method tends to leave ridges on the floor which, unless removed by further blasting, may seriously interfere with the operation of shovels and transport vehicles. The use of toe holes reduces this disability

greatly. If the "back break" exceeds the burden toe holes may also be a necessity to maintain the required burden for the next row of holes. Explosives used in open-cast mining are usually of medium to low strength dynamites or granular powders. Recently, however, especially in the Americas, the newly-developed ammonium nitrate-fuel oil mixtures are finding general application and bid fair to supplant the dynamites for this type of work.

In hard rock it is customary to load gelatine explosive in the bottom of the blasthole and to use detonating fuse for the initiation of the explosion. Electric delay caps or safety fuse, with igniter cord in the last few years, are employed to detonate the charges.

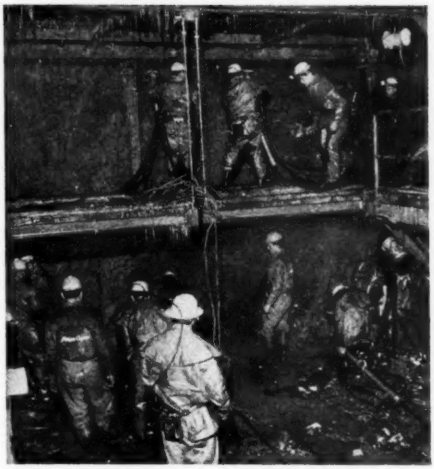
No hard and fast rules can be laid down for diameter of holes, spacing, and size of charges. These depend on the nature of the ground and are determined finally by experiment. In general, small holes and close spacing result in better fragmentation. Explosive efficiencies vary greatly and range from as high as $\frac{1}{10}$ lb. per ton of rock to, in exceptional cases, over 1 lb. per ton. An average figure would be about $\frac{1}{4}$ lb. per ton of rock broken. In ground which will cave by its own weight vertical bench holes are sometimes dispensed with and only flat holes at bench level are drilled and blasted. This, however, is liable to be a hazardous method and requires precautions to ensure the safety of the miners.

Under some conditions tunnel or chamber blasting is practised. This entails the driving of tunnels at the base of the face and blasting charges placed in them. It is used for large blasts and gives low costs, but compared with blast-hole methods is liable to produce poor fragmentation. It also has the disadvantage that the back break cannot be controlled.

Underground Mining

The problems of underground mining are more varied and complex than those of open-cast workings and for that reason progress has, in most respects, been more spectacular. Although, basically, mining methods have undergone little change in 50 years the means of carrying them out have been vastly improved by the advances made in the design of equipment.

Shafts.—Shafts serve three main purposes—exploration, exploitation, and ventilation. Fifty years ago, because shaft sinking and level driving were slow processes, shafts were commonly sunk on the vein or close to it and were closely spaced to shorten driving and tramming distances. A spacing less than 1,000 ft. was not unusual, but to-day, with the immensely greater speeds obtainable in sinking and driving, and with mechanical haulage underground, these considerations are less restrictive. Except in the early stages of exploration shafts are now preferred in the foot-wall or, in deep mines, at considerable distances in the hanging-wall, and on large properties production shafts may be as much as two miles apart.



[Atlas-Copco

Drillers in the Mont Blanc Tunnel.

Combined vertical and inclined shafts, compound shafts, were not uncommon at one time, but are now obsolete. The slowing up of hoisting caused by the bend at the junction of the vertical and inclined sections, and high maintenance costs at that point, outweigh any original gain in shortening the depth of sinking.

Rectangular shafts, lined with timber sets, were standard in 1909 in metal mines in most countries outside Europe and India, but by the 1930's circular shafts were coming more into favour in most metal-mining fields. They were generally concrete lined. There are two schools of thought and many engineers still prefer either the multi-compartment long rectangular shaft, or the so-called square shaft, which originated in North America some 30 or 40 years ago. This shaft has a large counterweighted cage in addition to skip compartments, usually

two. It has the advantages that large units of equipment or gangs of men can be got in or out of the mine relatively quickly and long timbers and drill steel without rehandling. A similar design, however, can be incorporated in circular shafts and other considerations which cannot be discussed here, enter into the choice of the most suitable type of shaft. Timber sets are going out of fashion for main shafts ; steel or reinforced precast concrete is now generally preferred.

In 1909 few vertical shafts much exceeded 4,000 ft. in depth ; and below 3,000 ft. mines were developed almost invariably by internal vertical or inclined shafts—*i.e.*, by stage hoisting. This practice is still followed if there is doubt about the continuity of the ore-body in depth, but when this is assured by positive evidence, as from core drilling, vertical shafts up to depths of some 7,000 ft. have been sunk in recent years. Good examples of this are in the Orange Free State, where many shafts have been sunk 5,000 ft. or more since the last war.

The main obstacle encountered in South Africa in planning these ultra-deep shafts with single-stage winding was the question of discard rope safety factor, which is prescribed by law. The additional weight of the long ropes would have reduced the pay loads to uneconomic amounts and, although this could be alleviated to some extent by the use of lightweight skips and cages, it was not until 1935, when the mining regulations were amended to permit a lower factor, that ultra-deep shafts were feasible. In that year it was officially recognized that, taken in conjunction with the smooth braking characteristics of the hoists to be used, the reserve of strength in long ropes was sufficient provision for the kinetic stresses.

For transporting men and materials in vertical shafts cages are used, usually multi-decked if a large labour force has to be handled ; in inclined shafts skips are frequently used for this as much as cages. Ore and waste rock are hoisted in cars run into the cages, or in skips. Skips are self-dumping, either bottom or top (overturning) discharge. In 1909 skips were less common than cars, but they became almost essential when large outputs were called for.

At one time it was common practice to operate a skip and cage in tandem in vertical shafts to avoid having separate hoists and shaft compartments. In cases where output requirements outgrew shaft capacity the system had some merit, but is now outmoded. The purpose is best achieved by installing skip/cage changing arrangements, with the best of which a changeover can be made in a few minutes.

In small mines, or in cases where various classes of ore are hoisted, or where development rock is used for stope fill on various levels, cars hoisted in cages may still be justified.

Skip loads 50 years ago were generally of the order of 2 tons to 3 tons of ore, but even then much higher loads were being hoisted. For example, at Kimberley diamond mines 11-ton skips were in use, a size that even to-day is not often exceeded. A new shaft in South Africa, at Vaal Reefs mine, will have one of the highest duties of modern shafts. It is planned to hoist a 14-ton load of ore in one stage from a depth of 7,200 ft. at a maximum speed of 3,600 ft. per min.

Shaft-Sinking Practice.—This can only be given in outline in a review such as this, though it is of interest to record that modern practice is well covered by the Symposium on Shaft Sinking and Tunnelling held last July, arranged by the Institution of Mining Engineers.

Probably no other branch of mining operations has made such advance in the past 50 years as speed of sinking. Writing in 1909 Hoover put 40 ft. per month as a fair average in working shafts and referred to an exceptional case in which 213 ft. had been achieved. To-day 100 to 150 ft. per month would probably be a fair average where speed is not an all important factor, but rates approaching 850 ft. per month of completed shaft are now reached in new sinkings in South Africa, which for some years has held world records in this work.

Fifty years ago drilling was mainly by hand, though in large shafts piston machines were often used. They did not, however, add much to the speed of sinking and not until the hammer drill was perfected some time later was much progress in this direction made. With their use and that of other appliances records of 400 ft. per month were then reached. Drilling machines of the heavy hand-held jackhammer type are used for shaft sinking, but a recent development is the use of a specially designed jumbo. One unit of this kind mounts six $3\frac{1}{2}$-in. machines.

The introduction of the Galloway stage, which allowed shaft timbering to be carried

out while drilling was in progress below, was a notable step forward in sinking practice. The development of this into the multi-stage platform is the key to the record rates of completed shaft sinkings achieved in South Africa. Its use enables shaft walling in the circular shafts to keep pace concurrently with sinking. Ready-mixed concrete, with a quick-setting additive, is brought down by pipe-line, or lowered in special containers.

Shaft cleaning after the blast was always done by hand until comparatively recently. Mechanization of this work began in the 1930's when, in long rectangular shafts, scraper slides delivering directly into the sinking buckets were first tried out. This method, which has greater application in inclined than vertical shafts, has generally been superseded by the use of rocker-shovels or grabs of the clamshell or cactus type. Grabs are suspended from the platform in such a way that they can be positioned at any required point in the shaft by moving the point of suspension along a moveable beam. Another design, in which a clamshell grab is mounted on the end of an adjustable arm attached to the platform, has proved most efficient also. It has the added advantage that it can be used equally well in inclined shafts.

For sinking through loose quicksand formations sheet piling and caisson methods were in use 50 years ago and are still employed to-day. Reinforced-concrete caissons are a usual construction now.

In water-bearing strata freezing and cementation have also been standard methods for well over 50 years and in that period have been considerably developed. In cementation it has been usual to cement the ground ahead in stages, up to more than 150 ft. as sinking progresses. This naturally causes delay while cementation holes are drilled, and cement pumped in, and recently in South Africa, in order to avoid such delays, what is termed precementation has been found successful in some cases. In this method one or two vertical holes outside the periphery of the shaft are drilled and cement pumped in in stages well ahead of sinking. A depth of 4,000 ft. has so far been successfully treated in this way.

In ground too porous for satisfactory cementation chemical methods have been used for many years. In these sodium silicate is the basis of a chemical reaction in which aluminium silicate is precipitated in the pores before cementation. Recently there have been further developments in chemical grouting, using organic chemicals from the plastics industry, and further advance on these lines can be expected.

Mechanical Mucking in a Modern Shaft.

Core drilling has been adopted for drilling small shafts up to diameters of about 6 ft., the first full-scale results being obtained in the U.S.A. in the middle 1930's. In one case a $5\frac{1}{2}$ ft. diameter shaft was drilled 1,200 ft. in $8\frac{1}{2}$ months. A special type of shot drill was used in which the driving motor is close to the bit, the operator working down the hole. After drilling for a few feet the core is cracked off by a light explosive charge and lifted to the surface by means of a " catcher."

In a more recent design the kerf is cut by a series of roller bits. Diameters up to 8 ft. have been cut by this drill.

A shaft boring method is also reported from Russia. The machine consists of three or four turbo drills, using roller core bits, which rotate about the axes of the shaft and cut out the full diameter. The mud slush drives the drills and removes the debris.

Lateral Development

Tunnelling.—Although piston drills were used extensively for large tunnelling projects

well before the beginning of the century, they had not seriously displaced hand drilling in metal mines in 1909. About that time hammer drills were just being developed and not until some time afterwards were they firmly established. When this took place the speed of driving advanced considerably, 200 ft. to 300 ft. per month being possible. Greater speeds were obtained when mechanical loaders were introduced into mine tunnel driving and such has been the progress in the design of these machines in recent years that rates approaching 2,000 ft. per month are now in sight. Such high-speed driving is justifiable only in special circumstances and for success requires careful planning.

The pattern of drilling rounds has not changed greatly in the period, the main change being that modern appliances such as jumbos and air-legs enable rounds to be drilled more accurately and quickly than before. In recent years the burn-cut type of round has become popular. Longer rounds can be pulled with it than with conventional cuts.

Large boring machines, capable of boring tunnels by means of rotating cutting heads, have been developed in recent years. In Russia a machine of this kind using multiple cutting bits can bore a tunnel 18 ft. in diameter and in the U.S.A. one that cuts to a diameter of nearly 30 ft. has been used. Another boring machine, which cuts a kerf to which the core is broken, bored a tunnel of 25 ft. in diameter for several miles in shale at the Oake dam, in South Dakota.

The method of breaking to a kerf shows promise of becoming applicable to hard rock tunnelling when a suitable bit has been developed.

Winzing.—Winzing methods have changed little in 50 years. Jackhammers have replaced hand drilling, but cleaning out is generally manual. Winzers are mostly too small in cross-section area to permit the use of mechanical shovels or grabs.

Raising.—In raising there have been introduced in recent years improved methods over the old-established practice of drilling from a temporary wooden stage or from the top of a timbered compartment carried up with the raise.

One of these new methods is the " cage raising " system, applicable to vertical raising. In this the raise round is drilled from a cage suspended on a rope which passes through a bore-hole to a hoist on the level above. Before blasting the cage is lowered out of the raise and the rope detached and pulled into the bore-hole clear of the blast.

In Sweden considerable attention is being given to the development of other methods also. These include the use of a platform elevator—the Alimak—which by means of a powered rack and pinion is raised on a guide rail for drilling the round and lowered out of the way before blasting. Other methods using ladders for access and support of temporarily rigged drilling platforms are being used as well.

A system in which the whole length of the raise is pre-drilled from the level above with parallel holes is being tried out. A burn-cut type of round is blasted, using the pre-drilled holes, the charging being done from the top level. Rounds of 6 ft. to 12 ft. are blasted at a time. The main difficulty with this method is that of drilling the holes parallel throughout the length of the raise.

The great advances in the past 50 years in speeds of driving development headings has had a considerable influence on the layout of metal mines. Ore deposits can now be explored and exploited much faster, with the result that shafts can be spaced further apart, level intervals can be increased, and stoping methods involving much preparation work can be employed more readily.

Mining Equipment

Rock-Drills.—The piston drill was the first practical machine for drilling hard rock. It was invented in the early 1850's and was operated by steam before compressed air became universally available. It remained supreme in the field until the advent of the hammer drill which, associated with the name of Leyner, was produced about the end of the century.

In 1909 machine drills were generally heavy and clumsy and not very suitable for use in narrow workings. In that year competitive trials of various makes of drills were held in South Africa to encourage the production of a lightweight handheld machine drill for use in the narrow stopes of the Witwatersrand mines and this marks a definite step in the development of the jackhammer.

The heavy drills, used mainly for driving tunnels, were at one time always mounted on columns, fixed in position by means of screw jacks. The labour and time consumed in transporting and setting up this heavy equipment was high and unproductive and to

Filling Wagons in a Newfoundland Iron Mine.

reduce this loss drill carriages or jumbos on which the drills were mounted were developed. They ran on the mine tracks and could be positioned at the face with much less effort. These types are still used, but the trend now is towards the use of trackless jumbos with crawlers or rubber-tyred wheels, particularly in the large headings. On the largest models as many as six drifters may be mounted and in the latest designs the drills are positioned and operated by remote control.

About 20 years ago the air-leg for use with jackhammers was introduced. It greatly lessened the labour of drilling with hand-held jackhammers and in combination with tungsten carbide bits has revolutionized drilling practice in hard rock. In development headings jackhammers with air-legs have in many instances replaced drifter machines.

Manually-operated screw feeds on drifters, though still in use, have been superseded by automatic rotary or vibratory designs which first came in the late 1920's.

Stopers, for drilling upper holes, were produced over 50 years ago. In the early types the machine and drill stem were rotated together by hand, but later automatic rotation of the stem alone was provided.

Drill rods or stems originally were solid steel, but by 1909 the hollow rod for wet drilling had been introduced. In this connexion it is interesting to note, however, that one of the findings of the investigation committee which conducted the drill trials in South Africa (mentioned above) in 1909 was " that hollow steel cannot be recommended owing to its high cost and difficulty of tempering." Nevertheless, the imperative need to suppress the dust from drilling in the interests of health, and advances in the technique of drill-rod manufacture, outmoded such considerations and hollow drill steel soon became almost universal in all metal mines.

Wet drilling suffers from the drawback that it increases humidity of the air and in deep hot mines this becomes a limiting factor in working conditions and hence to depths at which mining can be carried out. Consequently, in recent years attention has been given to methods of suppression of dust from drilling other than by the use of water. The chief of these is the extraction of the dust by suction into a collecting container, and this type of machine drill is now well established.

For long-hole drilling in stoping, where space is restricted, screw jointed rods are used or flexible rods of flat rectangular section, which can be sprung to enter the hole.

Bits at the beginning of the period under review were chisel or cross shaped, forged by hand on the rod ends, but later mechanical

forging was developed and large mines were well equipped with comprehensive plants for forging and tempering. To reduce the transport of stems in and out of the mine detachable bits, of both the screw-on and taper-fit variety, were introduced in the 1930's, but the greatest advance in design came with the introduction of the tungsten carbide (T.C.) bit after the last war. This originated in Germany some time before and has invaded all mining fields since. It has made the old conventional steel bit obsolete and the elaborate forging and tempering plants also. The T.C. bit is resharpened by simple grinding methods.

Faster drilling and thus more holes per man shift are among the outstanding features of the T.C. bit and it has appreciably reduced the cost per ton of rock broken. Two types of drills are used, one in which T.C. inserts are welded into the end of the stem—*i.e.*, tipped steel or integral drills—and the other in which the bit is detachable. These latter may be of the " throw-away " type, which are not resharpened when once worn, and the bit that will stand several resharpenings before being discarded. Both types have their advocates.

Other forms of hard metals, such as titanium and boron carbide, are being developed and may eventually supersede the T.C. bit.

In underground mining rotary drills for ore production have not yet found much application, though the diamond drill, of both the coring and non-coring variety has been competitive with the percussive drill in long-hole drilling and in the drilling of burn cuts. Much research is in progress and this type of drill, perhaps a rotary percussive down-the-hole variety, may be the drilling machine of the future.

Loaders.—Although scrapers and mechanical shovels were used in open-cast workings before the end of the 19th Century, mechanical loading in underground mines was not introduced until some years after 1909. The first mechanical shovels were of the type used on the surface, but since they required large clearances more compact designs were evolved for underground conditions.

By 1920 the scraper slide was in common use in the larger metal mines, and has undergone little fundamental change in design since. Normally it loads one car at a time, but some designs permit the loading of a train by extending the slide along the tops of the cars. Scrapers are the most versatile of all mechanical loaders. Besides their use with the slide they are used as straight transfer machines, loading into chutes in stopes and other working places such as sub-level and scram drives. They are useful for cleaning out sumps and other excavations and by the use of three-drum hoists can clean up over a wide area.

The design of shovel loaders for work in confined areas has changed considerably since the early open-cast type were adapted for underground work. They are now mostly of the rocker type in which the loaded bucket is swung completely over the machine for discharge into a car behind, or on to a conveyor for loading a string of cars.

There are several combinations of loader transport units now in use. In one the loader is linked to a shuttle car, the two machines working together as a single unit. Another, such as the " Gismo," consists of a tractor-mounted rocker shovel which mounts a ramp to discharge its load into a train of cars behind. A third type consists of a jumbo-loader unit which after loading is used as a drill jumbo, the bucket being lowered out of the way of the drills.

Gathering-arm loaders, originally designed for coal, are finding application in metal mines, but chiefly when the ore is of the less abrasive kind.

The modern trend is to mount loaders on crawlers or rubber-tyred wheels, the latter being preferred when the ore is abrasive.

The use of mechanical loaders has greatly speeded up development work. For example, a 6 ft. round in an 8 ft. by 8 ft. heading, which would take two men the best part of an 8-hour shift to clean out by hand, could be done by one operator in less than half an hour in similar conditions with a loading machine.

Locomotives.—Few locomotives were working underground in 1909. They were either compressed air or electric trolley and it is of interest to recall that writing in 1909 Hoover expressed the view that mechanical haulage was seldom applicable to metal mines, because haulage ways changed frequently, were often crooked, and were usually of short life. So much have conditions changed since then that to-day no average-sized mine could operate economically without mechanized haulage. Compressed-air locomotives are still employed but have largely been replaced by electric or diesel locomotives.

Storage-battery locomotives came later

and are now more widely used underground than possibly any other type. They are high in first cost on account of the battery, but more flexible than the trolley since no overhead cable is required. They do, however, need a charging station on each working level, unless the shaft cages are large enough to transfer them to another level for charging.

The trolley locomotive is used chiefly in main haulages ; in small tunnels and at loading chutes the overhead wire is a source of danger and an inconvenience.

Diesel locomotives were slow in coming into general use in underground metal mines, especially in the U.S.A. The main problem associated with them is that of adequate ventilation to disperse the noxious exhaust fumes, apart from the need for flame-proofing in gaseous mines. Since the last war, however, they have come into greater prominence and they now rival battery locomotives in numbers. They are even more flexible than the latter, since they require no charging stations. They cost less, but unless good preventative maintenance measures are taken their running costs can be high.

Diesel crawler or rubber-tyred tractors are also finding application underground, chiefly for drawing cars over fairly short distances between loading and dumping points.

Endless-rope haulages, or cable-ways, were well established in 1909 and are still employed to-day. With special arrangements they can negotiate undulating gradients up to about 20° inclination, but in such conditions are liable to be dangerous from runaways. Their main application is for long flat hauls and for this purpose they are largely used in the flat dipping areas of the East Witwatersrand, where haulages of 2,000 ft. or more in length have been equipped with them. Running costs are probably the lowest of any form of underground transport.

Cars and Trucks.—Fifty years ago, when locomotive haulage had hardly arrived, underground cars were drawn mainly by horses or mules or pushed by men. They were thus generally of small capacity, since about $\frac{3}{4}$ ton was the limit one man could handle in this way in comfort. The cars were of simple construction, often of wood, but steel was also being used. Bearings were plain and tracks were light, 20-lb. rails being about average.

With the introduction of locomotives cars and trains grew in size and to-day a trainload of half a dozen or more 15-ton cars is not unusual on a main line in a large mine. Ball or taper roller bearings and heavy rails up to 90 lb. per yard are used in these large installations and speeds of 35 miles per hour are reached in some underground haulage levels. Traffic control systems based on railway practice are frequently required and in one case at least, where various classes of ore drawn from widely-scattered points have to be transported to a central point, the electronic computer is employed to control the signals.

Hand tramming is by no means out of date, for mines vary greatly in their scale of operations and often small output and short-lived levels will not justify mechanization. Many types of cars of all sizes are used underground. They include side, bottom, and end dumping, automatic or otherwise, light and heavy construction. The importance of good tracklaying and maintenance is appreciated more than it used to be, due to the high standards required by locomotive traction.

Conveyors.—These were well established in coal mines as a means of transporting coal underground before they found much application for a similar purpose in metal mines. In the last 25 years, however, they have become an almost standard item of equipment, in competition with track transport or scrapers, for moving ore or waste in metal mines. For economical operation the rock should be reasonably fine and dry and the supply steady and sufficient to ensure long running periods.

Belt-conveyors are often used for transporting waste fill to main distribution passes, for transferring ore from one pocket to another, and as a controlled feed to measuring flasks at skip loading stations.

Shaker conveyors are used in cut-and-fill stopes for distributing the waste fill and in flat open stopes for getting the broken ore out to the tramming levels, amongst other applications. Drag conveyors are also being used instead of scrapers in some cases in scram drives, where the ore is not too abrasive.

In recent years there has been a marked tendency to use trackless equipment underground rather than rail-mounted jumbos, loaders, locomotives, and cars. Operations can thus be made more flexible and expensive track laying is avoided. On the other hand, maintenance costs are higher and unless skilled labour is readily available breakdowns can prove expensive.

Incompatible Waters in Porous Media

Effects of injection water reaction with pure water when flooding an oil sand

Oil sands may become plugged naturally if two or more incompatible waters should come together in the reservoir, or this same type of plugging may take place during water-flooding operations if the injection water is not chemically pure. Interstitial and injection waters usually contain a number of inorganic salts in solution. These salts are mostly chlorides, sulphates, and bicarbonates of sodium, calcium, magnesium, potassium, strontium, and barium. Many other ions may also be present in small concentrations. Therefore several different chemical reactions are possible should two or more of these waters come together. Although the quantity of these precipitates which may form is small, it is also true that the quantity necessary to cause serious plugging in a well is quite small. The extent of the plugging effects will depend not only on the amount of precipitate formed, but also on the nature of the precipitate. One of the controlling factors in the amount of plugging that will take place in a reservoir is the degree to which the incompatible injected water and interstitial water mix.

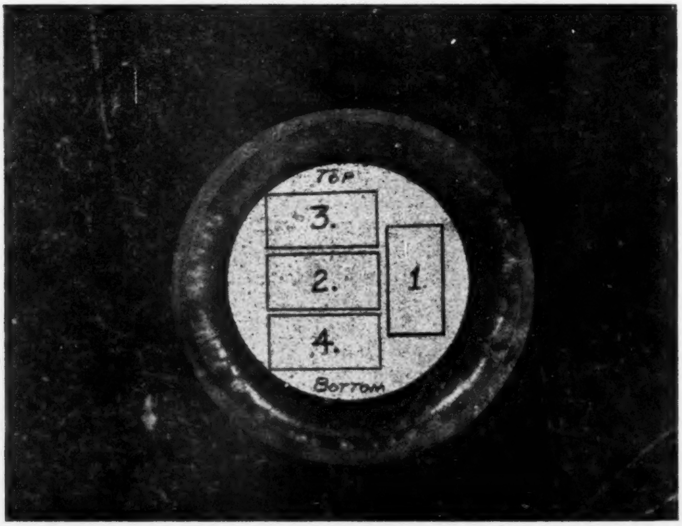
There have been several articles published on the reactions between interstitial water and incompatible waters but there has been very little agreement as to the effects of the precipitation.[1]

Procedure

Laboratory work recently performed at the School of Mines of West Virginia by R. W. Laird and A. F. Coghill generally consisted of the reproductions of the more common reactions which can take place between interstitial water and injected water. This was done by simultaneously injecting two incompatible waters into sandstone cores. This reproduced the condition existing in a reservoir at the contact between the interstitial water and the injected water. The rate

[1] A short list of references is given at the end of this article.

Fig. 1.—Core Pattern.



of flow through the cores was measured until there was an indication of plugging in the cores. The cores were then sliced and representative slices cut into smaller square cores in the pattern shown in Fig. 1. The permeability of each of the small square cores was determined, the precipitate extracted, and the permeability redetermined. The difference in the two permeabilities showed a decrease in the permeability due to the precipitation of salts from the incompatible waters.

Several factors were given special consideration in the West Virginia investigation. It was carefully noted whether the plugging occurred at a thin interface where the solutions came in contact or whether the plugging was fairly uniform throughout the core. Special consideration was also given to the distribution of the plugging through the length of the core—that is, it was carefully noted whether the precipitation occurred at the inlet end of the core or whether it was fairly uniform throughout the length of the core.

It should be emphasized that the solutions used in these experiments were somewhat stronger than those found in nature. The reason for this was that in the reservoir the incompatible waters remain in contact with each other for a much longer time than was practical in the laboratory. Therefore by using stronger solutions in the laboratory it was assumed that the same or nearly the same end results could be achieved. Interstitial waters commonly found in oil reservoirs contain several inorganic salts in solution in amounts varying from a few parts to more than 300,000 parts per million. These salts consist of chlorides, sulphates, and bicarbonates of sodium, calcium, magnesium, potassium, and barium. Other ions that are sometimes present are bromide, iodide, sulphide, phosphate, silicate, carbonate,

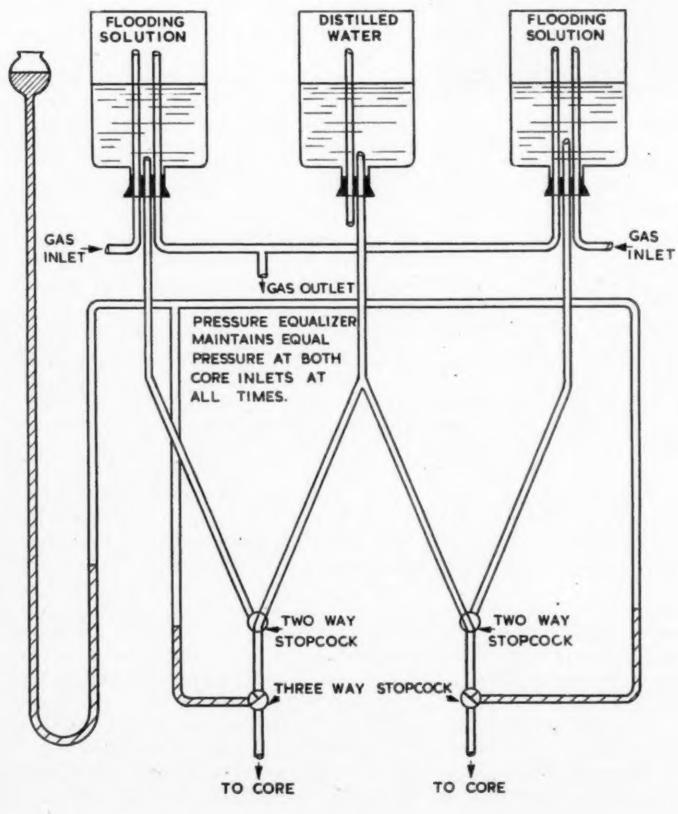


Fig. 2.—Flow Diagram.

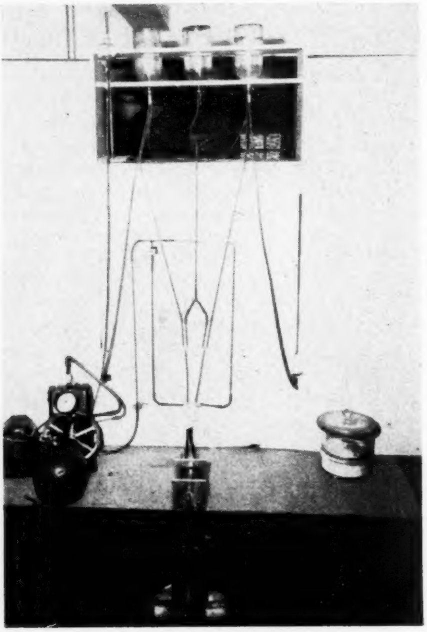


Fig. 3.—Flow Equipment.

iron, manganese, aluminium, lithium, and ammonium. Table 1 shows representative analysis of several typical interstitial waters in parts per million.

Table 1

Constituent	*Water A*	*Water B*	*Water C*
Sodium chloride	65,647	61,363	7,888
Sodium bromide	244	—	5
Potassium chloride	622	695	162
Lithium chloride	110	160	35
Ammonium chloride	86	80	9
Barium chloride	812	274	27
Strontium chloride	220	208	3
Calcium chloride	16,375	24,154	734
Magnesium chloride	5,421	6,295	411
Calcium bicarbonate	290	30	Trace
Ferrous bicarbonate	90	119	—
Manganous bicarbonate	83	97	Trace

The cores used in these experiments were cut from the Homewood Sandstone of the Pottsville Series. This sandstone is almost a pure quartz sandstone with a near pure quartz cementing material. This eliminates the possibility of changes in permeability due to swelling of clays that may be present as cementing material. In the particular section where the cores were cut the permeability decreased by going up the section stratigraphically. This made it possible to obtain cores of various average permeabilities for the flow tests.

The cores were encased in a combination of lucite tubing and a liquid polymer resin which hardened on the addition of an agent. The encased cores were then clamped between two flat pieces of aluminium, with a piece of copper tubing projecting from the discharge end to collect the solutions, and two pieces from the entrance end to admit the two solutions.

The equipment consisted of a system by which two solutions could be simultaneously injected into a core at equal pressure. This was done by suspending the solutions a few feet above the core (Figs. 2 and 3). When beginning a flow test the core was placed in a vacuum chamber and subjected to a vacuum of 27 in. of mercury. After about two hours distilled water was admitted to the vacuum chamber until the core was completely immersed. Atmospheric pressure was then admitted to the chamber forcing the water into the core. It was assumed that the core's connected pores were 100% saturated with water. This was necessary because at the low pressure used air in the core would prohibit the flow of the incompatible solutions.

A split gasket was used at the entrance end of the core to prevent the two solutions from mixing before entering the core. Distilled water was first allowed to flow through the core to establish equilibrium flow before the solutions were admitted. The solutions were then allowed to flow until plugging was indicated by a decrease in the flow rate. The flow time varied from about 5 to 18 or 20 hours. After the flow period of the two solutions the stopcocks were switched back to distilled water and flow continued until enough water had passed through the cores to remove the excess solutions from the pores of the core. The cores were then cut into half-inch slices and from each slice four small square cores were cut for permeability tests (see Fig. 1). After permeability determinations on each small square core they were placed in Soxhlet extractors for about ten hours to extract the precipitate. The small cores were then dried and the permeability redetermined. The apparatus used to determine the permeability was a modified Penn State " permeameter ".

Five different flow tests were performed on five large cylindrical cores. All solutions were

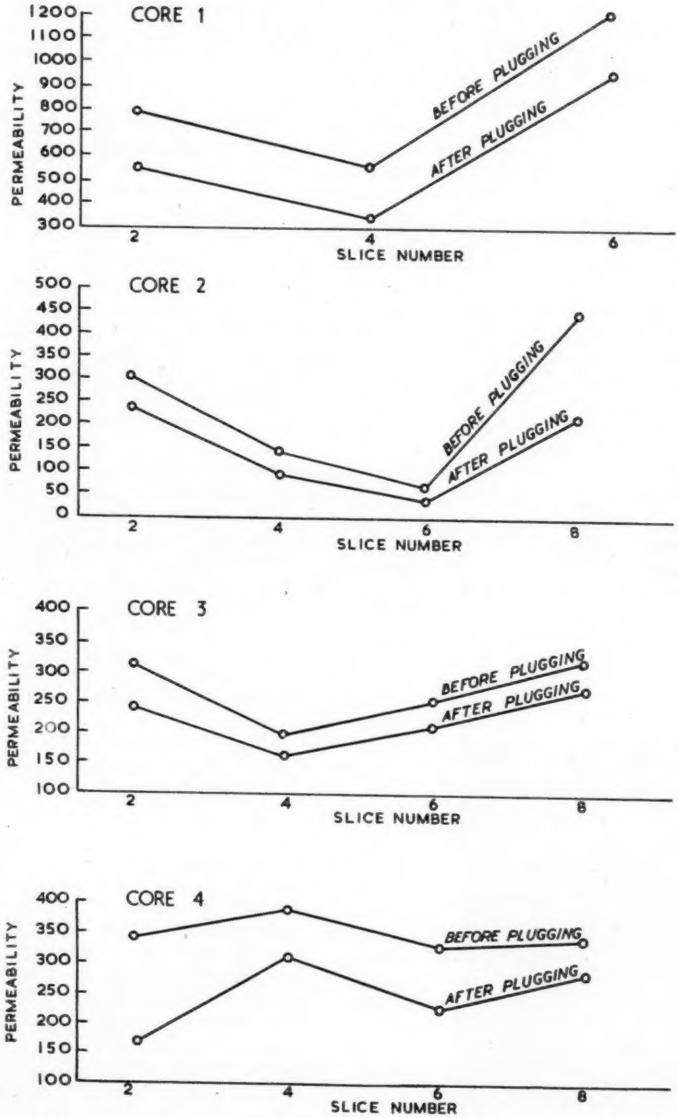


Fig. 4.—Variations of Permeability along Core Lengths.

filtered twice to remove any foreign matter. In the first flow test a sulphate reaction was studied using a calcium chloride solution and a sodium sulphate solution as the incompatible waters. Twelve small cores were cut from the cylindrical core of the first flow test and the permeabilities were decreased from 15% to 62% with an average decrease in permeability due to plugging by the incompatible waters of about 33%.

In the second flow test the same solutions were used for the incompatible waters as were used in the first flow test. In this test the core was less permeable and the solutions were allowed to flow through the core a longer period of time. This was done in an

attempt to gain some correlation between the amount of flow and the amount of plugging. Sixteen small cores were cut from the second cylindrical core and permeabilities were found to have decreased from 14% to 70% with an average decrease about 38%.

In the third test a sulphide reaction was studied by using ferrous chloride and sodium sulphide as the incompatible waters. Since these solutions oxidize in air to ferric chloride and sodium sulphate respectively it was necessary to circulate natural gas over the solutions throughout the test.

Sixteen small cores were cut from the third cylindrical core and permeabilities were found to have decreased from 8% to 34%, with an average decrease of about 18% and in the fourth test a carbonate reaction was studied by using a calcium chloride solution and a sodium carbonate solution as the incompatible waters. Sixteen small cores were cut from the large core and a permeability decrease of 15% to 52% was observed, with an average decrease of about 25%.

In the fifth flow test an oxidation reaction was studied. One of the incompatible waters was a solution of ferrous chloride. The other water was distilled water saturated with oxygen. The oxygen was continuously bubbled through the water to insure saturation. Natural gas was also circulated over the ferrous chloride to prevent its oxidation before it entered the core. Sixteen cores were also cut from this large test core and a permeability decrease of 15% to 33% was observed, with an average decrease of about 23%.

For all five tests the average decrease in permeability due to the precipitation of incompatible waters was 27·5%. As was previously mentioned, the solutions used in these flow tests were somewhat stronger than those normally encountered in a reservoir. It was assumed that the added strength of the solution (5% to 9%) would counteract the long time interval that the incompatible waters in the reservoir are in contact with each other thus giving the same plugging effect.

Before extraction of the precipitates with the Soxhlet extractor blank samples of the sandstone were checked to see that the cores contained no soluble cementing material. Since no soluble cementing material was detected in the sandstone the decrease in permeability was directly due to the plugging characteristics of the insoluble precipitates. The cores were of heterogeneous permeability, as noted by plotting the permeability *versus* position of the slice in the large core (see Fig. 4).

Fig. 5.—Formation of Precipitate in Core.

Conclusions

The results show that under some reservoir conditions great harm can be done to the effective permeability of the rock by the intermingling of these waters. In all the flow tests performed in this investigation, using the more common reactions occurring in nature, it was found that plugging occurred to such an extent that, in many cases, a reservoir could be completely ruined. In Fig. 5 it will be noted how precipitate has formed throughout most of the core. The slice used for this photograph was cut from about midway between the ends of a large test core.

It is therefore concluded that the amount of plugging occurring between an incompatible injected water and interstitial water is directly dependent upon the amount of mixing between the two waters and thus directly dependent upon the permeability profile of the reservoir in which the intermingling of the water occurs. It is also

concluded that an operator should, on no account, inject a water into a reservoir that is incompatible with the interstitial water in the reservoir.

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Indium and Gallium

M. Schofield, M.A., B.Sc., F.R.I.C.

Developments in the industrial field briefly reviewed

Following the discovery just 100 years ago of the flame spectrometer or spectroscope by Bunsen and Kirchhoff a number of new metallic elements came to light. Some of these metals are still classified as " rare," even though they have found more industrial applications than the two alkali metals—rubidium and caesium—discovered immediately following Bunsen and Kirchhoff's interesting find.

Indium and gallium are interesting examples of such " rare " metals separated last century yet only within recent years finding their place in commerce. Indium made its debut in 1863, when Reich and Richter were examining specimens of zinc blende, while gallium was described some 12 years later by Boisbaudran.[1] Both metals have been fully studied from the pure chemistry point of view by now, yet, apart from the important application of indium in aircraft sleeve-bearings, there has been no military significance to bring an intensive drive for increased production as with certain other metals hitherto regarded as rare.

Indium was first detected when Ferdinand Reich, of the Freiberg School of Mines, and his assistant Richter were examining minerals for the mining school collection and when Reich, in his search for thallium in zinc blende, discovered something new or unknown. Some zinc ore submitted to a flame test gave an indigo-violet colour and in the spectrometer a brilliant indigo line, with two lines fixed later.

The discovery serves to emphasize the significance of the introduction of the spectroscope, for, after rubidium and caesium had been detected by Bunsen and Kirchhoff, Sir William Crookes discovered thallium, Reich and Richter followed with indium, while gallium, helium, ytterbium, and half a dozen other rare-earth elements were added to the score. The two Freiberg metallurgists followed up their first detection of indium by preparing the metal by reduction of the oxide mixed with soda ash on charcoal, a later preparation of theirs being superior and consisting of reducing in hydrogen and melting the indium under fused potassium cyanide. Though widely distributed the element only occurs in very small quantities ; hence up to the 1920's no more than a gram. or so of pure indium metal was available—a contrast to to-day, when resources of indium are equal to any of the industrial demands at present made.

Gallium resembles indium not only in the

[1] *Chemical News*, 1875.

mode of its discovery, and in being classified in Group III in the periodic table, but in being available for increased production in commerce should new applications prove more promising than in the case of gallium-in-quartz thermometers, which declined after a period of boosting. That great classifier Mendeleeff predicted in great detail an unknown element he named "eka-aluminium" to fit into a vacant place in Group III; yet gallium only came to light when Boisbaudran, a French chemist noted for using the spectroscope in studying rare earths, investigated his zinc blende samples from the Hautes Pyrenées. Boisbaudran heated a residue precipitated from a solution of the blende by adding zinc metal, noted a new violet line in the spectrum, and named the new element gallium in honour of his native France. His first sample of gallium metal came when he electrolyzed a solution of gallium hydroxide in potash, while later by working up 4,000 kg. of zinc blende at the Javel works Boisbaudran obtained 75 g. of gallium, thanks to the zinc-mining interests of La Vieille Montagne and La Nouvelle Montagne presenting him with quantities of gallium-bearing mineral.

Indium to-day is seen as a bright metal with such an attractive lustre, polish, and corrosion resistance that the electroplating industry has adopted it for special finishes. From solutions of the cyanide, sulphate, or fluoborate the metal can be plated on most common metals, although with iron an undercoat of non-ferrous metal which alloys with indium is recommended. Attention has been given to indium following the introduction of low-melting alloys, of dental alloys, glass-sealing metals, and its invaluable role in sleeve-bearings when coated with lead and silver, the indium diffusing into the lead. Inclusions of up to 18% indium in Wood's metal gives an alloy melting at 40° C., for example, this being used in dentistry and plastic surgery. The properties of gold and platinum-base dental alloys are improved by inclusion of 1% to 2% indium instead of zinc. While the Consolidated Mining and Smelting Company of Canada and the Indium Corporation in the United States have been prominent in surveying the industrial possibilities of indium in general, the Cerro de Pasco Corporation has been most active in offering a series of such low-melting alloys of present or potential use in safety-plugs and in foundry patterns as well as in surgery. A 50–50 indium-tin alloy produced by the company can wet glass and is invaluable in preparing glass-to-metal or glass-to-glass joints, particularly when higher temperatures are prohibited. Indium is marketed as sheet, wire, powder, and fabricated parts, and is attracting interest in the field of electrical contacts, in imparting strength and hardness as well as corrosion resistance to aero-type copper-lead bearings where attack by acid oils must be prevented.

Following the pioneer work of Dr. W. S. Murray, of the Indium Corporation of America, a number of extraction processes have been devised for producing indium metal. Early in the 1940's it was shown that indium could be extracted from the zinc oxide fume in slag-fuming from lead blast-furnaces, while Mills, Hunt, and Turner in 1953 described the development of the Canadian process used at Trail for extracting from slag from treating lead blast-furnace bullion dross. From the electrolytic zinc process some indium is obtained by precipitation with zinc dust in purification of the leach liquor before electrolysis.

Zinc oxide fume at Trail contains up to 0·2% indium and was leached in an early process with dilute acid or spent electrolyte, the leach liquor being neutralized to give a residue or sludge. This by further treatment with ammonia and hydrogen sulphide yielded a solution from which zinc or aluminium precipitated indium sponge. In the modern process at Trail indium is extracted by grinding the dross or slag from lead blast-furnaces, removing copper, and then sintering and reducing with lime and coke in an electric furnace. An electrolytic process using lead fluosilicate as electrolyte and furnace bullion as anodes is also used, the indium, with antimony, being deposited as anode slime. By roasting with sulphuric acid and leaching the mass with water to dissolve the indium sulphate a solution is obtained from which indium is precipitated with zinc.

In a patented process of the Anaconda Company (U.S. Patent 2,384,610) a variation in recovering indium from zinc oxide fume is used, leaching with very dilute acid taking up most of the zinc to leave indium undissolved. Then follows leaching with stronger acid to dissolve the indium. Chemical treatment to remove heavy metals is used after precipitating indium with sodium sulphite and, finally, the indium is precipitated from a purified solution using zinc dust.

The American Smelting and Refining Company has also patented two extraction processes, the first precipitating indium as phosphate, the second covering the extraction from lead-zinc metal by using lead and sodium chlorides to form a slag which contains indium chloride, precipitation with zinc dust being finally used.

To illustrate the fact that indium extraction has received wide attention, some mention should also be made of processes devised by the Cerro de Pasco Corporation in which indium is removed as a chloride slag and by the Indium Corporation of America in which indium is recovered from plating solutions by evaporation, igniting the residue, dissolving it and submitting to chemical purification, and recovering indium by electrolysis. One further indium recovery process used in Germany in working up Rammelsberg ores has already been dealt with.[1] Here again indium associates with the zinc through flotation, roasting, and reducing operations, and is recovered by acid extraction after cupellating the lead residues.

Turning now to gallium in industry, this sister element to indium may be recovered not only as by-product from lead and zinc production in the United States but also from copper working at Leopoldshall, in Germany, and from aluminium production by Alcoa. There are also considerable gallium resources in the United Kingdom, if, along with flue dusts already worked up, the 2,000,000 lb. of gallium estimated to be present in the soot and ashes from British coal burned annually are included. By leaching with caustic soda the " iron mud " precipitated from zinc sulphate solutions from zinc extraction in the Missouri-Oklahoma-Kansas region sodium aluminate and gallate are formed, further separation of aluminium from gallium being a difficult operation expected from the closely-resembling chemistry of the two elements.

The recovery of gallium from the sodium aluminate liquors from the Bayer process seems to have proved more practical, so much so that the Aluminum Co. of America is able to work it and offer gallium on the market. This recovery is an electrolytic type ; one using a mercury cathode into which the gallium diffuses, the gallium being dissolved out from the mercury to form sodium gallate. Further electrolytic treatment yields pure gallium. In the United Kingdom, following the publication of a review by Morgan and

[1] THE MINING MAGAZINE, Sept., 1950.

Davies [1] attention was directed to producing gallium (along with germanium for transistors) from flue dusts derived from burning producer gas. As with gallium production from other sources a complex processing is necessary to extract the metal from flue dusts, a regulus being obtained by smelting with soda, lime, carbon, and copper oxide ; after a chlorination process germanium tetrachloride is distilled off, while gallium chloride is removed later with isopropyl ether. The final purification involves an electrolysis of sodium gallate solution.

Gallium, silvery-white and with a melting point of 29·8° C. and a boiling point as high as 2,070° C., is something exceptional among metals as regards physical properties. Such a wide range in the liquid state would be expected by now to have brought considerable industrial applications. A first use regarded as of much value when introduced was in gallium-quartz thermometers, rivalling pyrometers or thermo-couples in having ranges up to 1,200° C. ; yet problems in production seem to have vitiated appreciable developments in this direction. A second application studied closely by the Atomic Energy Commission from 1949 is as heat-exchange medium, where the long range of stability of the liquid metal with low vapour pressure should prove invaluable in an atomic power plant. Yet here the high corrosion or reactivity shown by gallium towards other metals has delayed such application until suitable resistant plant can be devised. Gallium is only inert towards quartz, alumina, and other refractory oxides, and to graphite, tungsten, and tantalum. The metal is packed for transport in rubber or in Pliofilm or other plastic bags, containers which take up the expansion occurring when gallium solidifies.

Less corrosive than liquid gallium are very low-melting alloys like gallium-tin-zinc eutectic types melting at 17° C. and a gallium-indium alloy with m.pt. as low as 15·7° C. Here again use as heat-transfer media is prohibited until their corrosive nature at high temperatures is solved. One example where gallium has proved invaluable is in cadmium arc lamps where a cadmium-gallium alloy does not adhere to the quartz body on cooling, while having little or no effect on the arc spectrum. With a wide range in frequency of the lines in the gallium spectrum, the element is used as substitute for mercury in vapour arc-lamps in laboratories.

[1] *Chem. and Ind.*, 1937, **56**, pp. 717–721.

Letters to the Editor

Vanadium

Sir,—The article by M. Schofield in the June issue dealing with "Vanadium in Industry" makes brief mention of mineral occurrences and it occurs to me that the following notes may be worthy of record :—

Vanadates of lead, zinc, and copper were noted in Western Australia in 1920 or thereabouts by the late Dr. E. S. Simpson. Vanadinite, mottramite and descloisite were found in ores from a region which may be referred to as "The Braeside Belt," which runs north from Mt. Sydney about 100 miles or so to the east of Marble Bar in the North West of the State. From excavations or tranches along the line of the outcrops in the proximity of Vanadium Creek many samples were obtained. The area was visited by the writer in 1926 and the occurrences confirmed on the spot, with plentiful showings. Whereas the normal strike of most of the lead veins or galena-bearing quartz veins was about 160°, the vanadium-bearing veins ran about 120°.

This Braeside Belt was examined on behalf of London interests and did not seem to have the potential to justify further development at the time. London "turned it down" but on several occasions since, despite the remoteness of the place, and other difficulties, there has been considerable activity which was stimulated by the better prices for lead. From Ragged Hills, a little to the south of Vanadium Creek, some thousands of tons of lead ore of good grade has been shipped. In the same locality also there has been activity in connexion with manganese ores.

Schofield refers to the "wide dissemination of vanadium in the earth's crust" and to its occurrence "as a vein mineral in some gold-bearing ores" in the form of roscoelite. It is significant that in ores of the Golden Mile in Western Australia there are often pale to deeper green patches with quite appreciable quantities of vanadium to which, T. A. Rickard referred in 1897. Whereas the presence of chromium might have been suspected, several analyses show that the amount of vanadium is greater. Many of the basic rocks from districts and areas round about the Kalgoorlie—Boulder area show an unusually large amount of vanadium—from 0·06% to as high as 0·30% V_2O_3—*i.e.*, the gabbros and epidiorites. Greenish cherts have been found in a number of localities and in the Golden Mile ores there are the greenish masses (referred to as "Green Leader" and often found to be of considerable richness) which are suspected as being vanadiferous rather than chromiferous. The position or relationship of chromium and/or vanadium has not been satisfactorily explained.

G. Spencer Compton.

Fimiston, W. Australia.

September 11, 1959.

Radioactive Minerals in Southern Nyasaland

Sir,—In recent papers Dr. Bosazza [1] tells us that he has made a detailed field and laboratory study of the radioactive mineralization at Tambani in Southern Nyasaland. Apparently, however, he has not got around to reading the relevant literature, for he could scarcely otherwise have been unaware of a brief but much-quoted official report [2] in which I have observed that :—

> In the Tambani district of Nyasaland alluvial river sands have recently been found to carry an unusual variety of radioactive minerals. Of 40 samples studied mineralogically, 39 contain monazite, 25 thorite, pyrochlore, and/or betafite, and 11 uranothorianite. There would seem to be a fair possibility that radioactive minerals are widely distributed in the syenite or other bed-rock whence these placers are derived.

Since no acknowledgment of this prior work is made in Dr. Bosazza's contributions, it is appropriate for me to record that the first identification of radioactive minerals in the alluvials of the Tambane district was made by the Atomic Energy Division of the Geological Survey of Great Britain late in 1953 or early in 1954, during a programme of routine radiometric study of the immense collections of heavy-mineral concentrates held in store by some of the Overseas Geological Surveys. The discovery of uranothorianite and other uranium minerals led immediately to a field reconnaissance in conjunction with the Geological Survey of Nyasaland, which in turn provided further

[1] Bosazza, V. L. "Radioactive Minerals in Southern Nyasaland," The Mining Magazine, vol. 101, 1959, pp. 49–55 ; "The Occurrence of Uranium in Ancient Conglomerates," *Econ. Geol.*, vol. 54, 1959, pp. 313–324.

[2] Davidson, C. F. "Radioactive Minerals in the Central African Federation." Paper P/760, *Proceedings of the (First) U.N.O. Conference on the Peaceful Uses of Atomic Energy*, Geneva, 1955.

samples for radiometric and röntgenometric investigation in London. It was the results of these systematic researches, undertaken (to the best of my recollection) by Mr. J. E. T. Horne and Mr. R. K. Harrison in the Survey laboratories and by Mr. D. Ostle and Mr. J. Taylor in the field, which laid the foundations for the commercial explorations in which Dr. Bosazza has been engaged.

C. F. Davidson.

St. Andrews, Scotland.
September 1, 1959.

Ore-Dressing Notes

(9) *Gravity Concentration.*

The Shaking Table (5)

In the control of a group of tables by the man on shift it is possible for one individual to manage 100 or more machines but only if operating conditions are steady. This implies a reasonable consistency in the feed—notably, a well-controlled water-solid ratio and a steady rate of feed which has been correctly classified. In this connexion it is highly desirable that all the water coming to the table is sent from a steady-head source and that none of it comes from supply mains which are liable to vary abruptly in pressure. Unless such precautions are observed it is not possible to avoid band-wander at the discharge section of a table and once this reaches any appreciable degree of swing efficient control of a number of tables by one person becomes impossible. Constant adjustment of cutters may be practised in a small plant where it is not possible to obtain steady head conditions but this is not the most efficient method of table control.

As with all other continuous operations in mineral dressing the prime requisite is steadiness at the feed end of the operation. To this in the case of tables must be added steady supply of the correct volume of wash water at any points along the table where it is fed in. This wash water is used to condense the bands being delivered by washing them gently down and if its supply is irregular or unevenly spread an immediate operating difficulty arises. Ideally the wash water should come quite gently and quite steadily over the whole linear distance for which it is provided. If necessary the supply should be controllable over two or more lengths rather than delivered from one valve over the complete length. This is because it may be desirable to have greater washing intensity on the washing plane nearest to the discharge end of the table than intermediately, where part of the purpose is to ensure downward drive of the upper layers of sand between the riffles. The wash-water volume must be balanced against the operating tilt about the long axis of the deck in order to obtain the desired width of cutting band. Assuming that head feed and wash water are constant the tilt can be adjusted to give a steady delivery within the required limits. This ensures that the cutters taking out concentrates, middlings, and tailings by their separate discharge routes need not be adjusted continually. Obviously this condition is well worth attaining and it inevitably leads to higher operating efficiency. The bands should be so adjusted that they are sufficiently wide for each true product to be taken in its correct cutting range. However thoroughly the feed has been classified and rationed for water there will almost inevitably be some small amount of band wander, so provision must be made for avoiding dilution of a high-grade concentrate by a middling which has wandered upwards and for prevention of loss through the entry of low-grade middling into the tailings band. This can frequently be aided by a system which cuts more than the three products, concentrate, middling, and tailing, and which allows for a high-grade middling to be recirculated or sent on. It is here that a good rougher-cleaner system is excellent, since it permits a final rejection of tailings and high-grade concentrate at the very first stage and allows the operator to set his cleaner section for better precision and closed-circuit return of inadequately separated material.

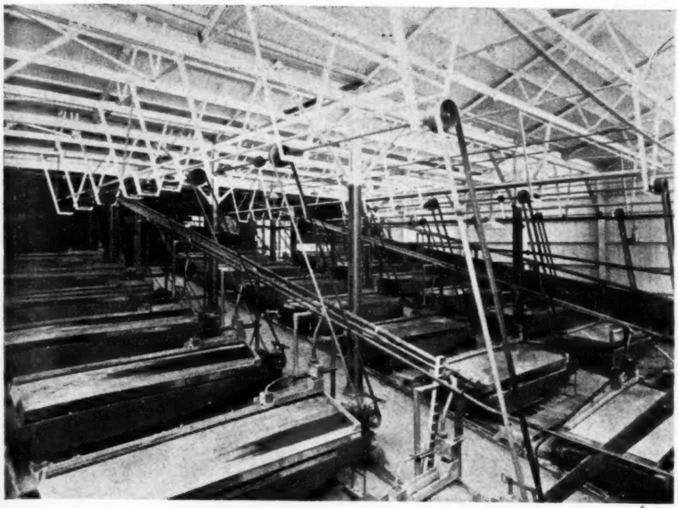
In assessing the table delivery mistakes can easily be made if judgment is confined to visual appearance. A good case of this is seen in the widely-used practice of running slimes tables with the vibrators in reverse. The reasons usually given are that much more efficient separation is thus obtained, as can be seen by examining the width of the concentrate band leaving the table and comparing it with the much smaller width of concentrate band produced when the vibrator runs normally. If, however, the operator will collect his concentrate under both sets of circumstances for a carefully-timed period

and weigh the product he will find that there is little or no difference between the amounts delivered. What he has done by reversing the vibrator action is to slow down the delivery rate of concentrate and, therefore, to broaden his concentrate band considerably. It is true that this broadening may have made it possible to exert more gentle final cleansing action at the delivery end of the table, but the main appearance is misleading.

This brings the discussion to the very important point of sampling check. Once steadiness of operation has been achieved the whole process should be expertly reviewed from the point of view of the operational control laboratory. For this purpose it is important to know not only the grade of concentrate, middling, and tailing, but also the change in grade inch by inch through the vital zones of delivery. To ascertain these points a simple sampling device can be contrived from a piece of troughed piping divided into suitable compartments inch by inch or some of 2 in. or 3 in. per run as desired. When the table is being checked for its performance samples are taken along the concentrates and middlings sections and well into the discharge end of the tailings continuously for a carefully-timed period. At the same time the samples now being produced should be roughly related to a head sample of feed coming on to the table. This head feed must not be so heavily sampled as to upset normal delivery to the table. The resulting products must be dried and weighed and then assayed for value content. Here panning or use of a superpanner may suffice. As a result a dependable picture can be built up of the progressive decrease in value round the discharge sides of the table and a metallurgical balance sheet can be constructed as between head feed and discharge products. The assay alone is not enough. The quantity involved must be known if intelligent improvement of table action is to follow.

As an example of what may be found when this work is put in hand it is not uncommon for the most serious loss of value to be discovered almost immediately opposite the feed box. This is caused partly by too violent a delivery, which causes a certain amount of the feed to run straight across the table and discharge before it has been properly arrested and bedded down in the riffles. It is also caused partly by poor classification which is allowing an undue amount of undersize for the particular table to come in with the main feed. Such undersize is not accommodated by the correct control settings for the main range of feed and consequently streams over straight to the discharge and is lost. The next point of interest is obviously the wander zone between the last of the middlings and the first of the true tailings. By knowing the delivery rate and the assay value over a closely-watched section of this the cutter can be positioned with greatly improved accuracy and efficiency. At the concentrates end there is the same interesting possibility for improvement. By knowing quantities and assays and by intelligent use of the microscope in order to see whether any of the dubious particles would be better for further grinding before re-treatment in a circulated middling a good deal of trouble can be avoided. The obvious need is to do as little grinding as possible once material is liberated. The secondary need is to avoid building a big blanket of recirculated middlings through which the concentrates struggle reluctantly. When this condition obtains the feed rate to the table must be reduced and the plant is not being used to its most economic capacity. Here the use of a close sampling technique such as is outlined above has the big advantage of allowing the operator progressively to reduce his recirculated middlings to a safe working minimum. He may also find it possible to cut one section of his middlings band as a result of the information thus yielded and to send it back for regrind before presenting it again to the classification section.

Nothing has been said in the course of this discussion of tabling about the adjustment of vibrators and similar mechanical matters. This would take these notes too deeply into matters which vary considerably with different types of table. One final point on tabling can, however, be made. Provided the principles at work are understood and correctly applied, and the head feed is properly steadied, the working up to full efficiency is best made by use of the close sampling technique mentioned above. If this technique is applied before the operator is assured of steady conditions at the feed end the work is, of course, wasted. As it is tedious and time consuming it should not be undertaken until the table is operating steadily. Where tables are running on interrupted shift systems this leads to difficulties and such a close procedure is rarely practicable. Most mills to-day run on a 24-hour cycle and in these cases, particularly when there is a good



Shaking Tables in a New South Wales Mill.

volume of material being worked, close attention to delivered quantities and qualities will repay the effort involved.

E. J. P.

(10) *Hazards.*

Plant Fires

In the old ore-dressing plants constructed largely of timber fire was a very real risk. This has largely been reduced by the modern use of asbestos, steel, and concrete, but a good deal of research on mill fires has been done and it might be of interest to examine the findings of experts in this field. The first point in approaching fire hazards is to study the potential causes. Next materials and supplies should be protected from ignition and third adequate fire-fighting equipment should be supplied at key points. Plant fires are caused by direct contact with flame, by prolonged application of a low degree of heat, by spontaneous ignition (due to oxidation, friction or chemical deterioration due to bad storage). Other causes include explosions, lightning, dust explosions, electric sparks, friction, focus of rays from the sun *via* mirrors, etc., static electricity, defective construction of buildings, and the presence of inflammable liquid gases. A hazardous process should be segregated from the main operation in a detached building or by means of fire walls and fire doors. Equipment should be kept dust tight and clean. Fire-fighting equipment should be serviced regularly and checked for its condition. Electrical equipment should also be looked at to see whether there is undue sparking or overheating. Good insulation is important where conductors pass through partitions or are held by supports. In an ore-dressing plant this is particularly important if vibration of the foundations is liable to initiate chafing between the supporting bridges of high-tension cables and the cables themselves. Transformers should be checked for oil level so as to ensure that this is above the arcing point of contacts. Arc-welding units may set up dangerous conditions. So can wiring which has been corroded by acids. Bearings should be kept aligned and belting should be grounded to prevent the build-up of static electricity. Air-conditioning plants should avoid the build-up of combustible material drawn in and deposited.

One important point sometimes overlooked is the danger to fire fighters of electrocution through the water they are squirting on a blaze becoming charged with high-tension and high-voltage electricity. Isolator switches should be available for cutting off electric supplies from all equipment in the burning area but must not, of course, interfere with the running of the pumps being used. It should be possible to turn off compressed air in the locality of the fire. This needs sufficient planning to ensure that the isolating points are well away from any likely danger area.

The major causes of fire have been analysed

by experts. The leading ones are smoking and the use of matches (nearly 30%), misuse of electricity (over 10%), exposure from nearby fires ($7\frac{1}{2}$%), and spontaneous combustion (7%). Sparks on roofs and defective chimneys and lightning also rank fairly high.

(11) *Grinding.*

Trunnion Lubrication

In a recent article E. J. Klovers [1] reports on developments in the lubrication of ball-mill trunnions which are designed to improve routine maintenance and reduce wear. With the steady increase in the size of mills increased attention is given to gearing and to the lubrication of pinion shafts, pinions, crown wheels, and trunnions. The new system developed by a leading American manufacturer takes care of a number of points liable to cause trouble if neglected and in addition provides for continuous correction of lubricant temperature and continuous filtration of contaminants. A typical bearing of the older type would have the trunnion dipping into an oil bath in the housing and perhaps a manually-operated high-pressure pump which injects up to a pound of lubricant into the space between bearing and trunnion so as to lift the latter during starting. It can also be used immediately before start-up of the mill. Systems based on this have been applied to mills up to 1,500 h.p. for the past two decades. Measurements show a trunnion lift varying from 0·002 in. to 0·009 in. depending on the quantity of oil pumped, its viscosity, the fit between trunnion and bearing, and the vigour with which the pump is used. The system is excellent provided the operator uses the pump correctly for about 15 sec. before and after the start of the mill, the bearing oil reservoir is correctly topped up and the oil free from contaminants.

One further condition, however, which arises with the modern large mills is not met by this system. When a mill is stopped it is warm and commences to cool and shrink longitudinally. If there has been a rise of the order of 30° F. a mill on 18-ft. centres will have expanded 0·042 of an inch. The trunnion system accommodates this while the mill is rotating, but during the contraction there is the risk of sliding taking place between a dry and unlubricated trunnion and its sleeve bearing. This can seriously reduce bearing life and also introduce bending stress in the supporting piers. This is obviated by using a high film strength in the oil, but a better method would be the periodic use of the manual high-pressure pump while the mill is cooling off. Such a system was developed when a $\frac{1}{2}$-h.p. motor was used to replace the high-pressure pump and the circulating oil was split between top and bottom of trunnion. This was followed some two years back by development of a motorized high-pressure pump which by means of a push-button control simultaneously floated the mill and started it. The break-away pressure was 1,800 p.s.i. and the static lift pressure 800 p.s.i., while the dynamic lift when the mill rotated was about 550 p.s.i. The weakness of the system is that it depends on manual stop–start operation of the motor and necessitates frequent inspection of reservoir oil level and high-pressure lines. If the pump runs too long or too frequently oil may leak through the bearing seals. No protection is given against drag during cooling off of the stationary mill.

These defects have been overcome in the new system in which there is a combination of high and low pressure under automatic control. Three pints of oil per minute are drawn from the bearing reservoir and returned through two channels each taking about half this quantity per minute to the aperture below the trunnion and above it respectively. Up to 5,000 p.s.i. are possible. The top lubrication line delivers $1\frac{1}{2}$ pints per minute at low pressure which is pulled into the rotating bearing. Each of the mill bearings must have its own $\frac{1}{2}$-h.p. system with its two pumps. Once the mill is running only a fraction of the horse-power is required and because the total amount used is low the pumps are kept running continuously. The advantages claimed are that the oil is thus continuously filtered and freed of all $+ 25\mu$ contaminants and water; cool lubricant is always ready; a built-in heater keeps the trunnion reservoir at 80° F. under thermostatic control; power expenditure in the overall system is less than previously; no elaborate switching is needed since the pumps run continuously; the trunnion is completely lubricated during shrinkage while cooling. The system is applicable to any mill bearing with an oil reservoir. If this is small a 5-gal. tank can be used as an intermediate reservoir.

[1] *Engg Min. J.*, March, 1959.

Iron Ore at Hartlepool

Two versatile types of machines are being used by the British Transport Commission, Docks Division, at the Middlesbrough and Hartlepools Docks for the discharge of iron ore. One is the Anthony loader-dozer, which combines the three functions of bulldozing, angledozing, and overloading and the other type is the 4-in-1 Drott skid-shovel, which, in addition to being able to doze, grab and shovel, can also backblade, all four movements being controlled by the driver from his seat.

The use of these two types of machines has been the outcome of investigations into methods by which difficult ships' holds could be cleared of ore without the need to employ large gangs for final shovelling and tubbing.

In 1955, the Transport Commission provided a new deep-water berth in the Old Harbour, Hartlepool, to facilitate the handling of increased tonnages of iron ore through the port and for the accommodation of the larger vessels being employed for the transport of ore and timber cargoes. Since the berth was brought into operation in November, 1955, imports of iron ore have increased from 130,000 tons to over 600,000 tons per annum and it is expected that this trend will continue until an annual importation of about 1,000,000 tons is reached.

Capable of accommodating vessels with a draught of 29 ft. at all states of the tide the new berth was equipped at the time of its construction with five electric level-luffing, single-rope, portal quay cranes, fitted for ring discharge, four being of 7½/3 tons capacity and one of 10/3 tons capacity. In 1958 it was decided to replace the single-rope units by 10-ton four-rope grab cranes, the first of which was brought into service during September, 1958. The quay surface is paved flush in concrete and has six railway tracks within plumb of the cranes.

Most of the ore is carried to the port in tramp steamers having 'tween decks, tunnel hatches, long ends and deep wings, all features which tend to slow down the speed of discharge because of the inability of the grabs to reach cargo stowed away from the square of the hatches. Originally, when as much ore as possible had been grabbed out of the holds, it was necessary to engage a greater number of dock labourers to make up tubbing gangs to shovel out the ore from stowage inaccessible to the grabs.

In an endeavour to improve the turn-round of vessels, however, the Transport Commission have experimented with the use of mechanical aids such as bulldozers, angledozers, and overloaders in ships' holds and two Anthony loader-dozers were purchased. Shortly afterwards the manufacturers of this machine produced the 4-in-1 Drott skid

Skid-Shovel Being Lowered into a Hold.

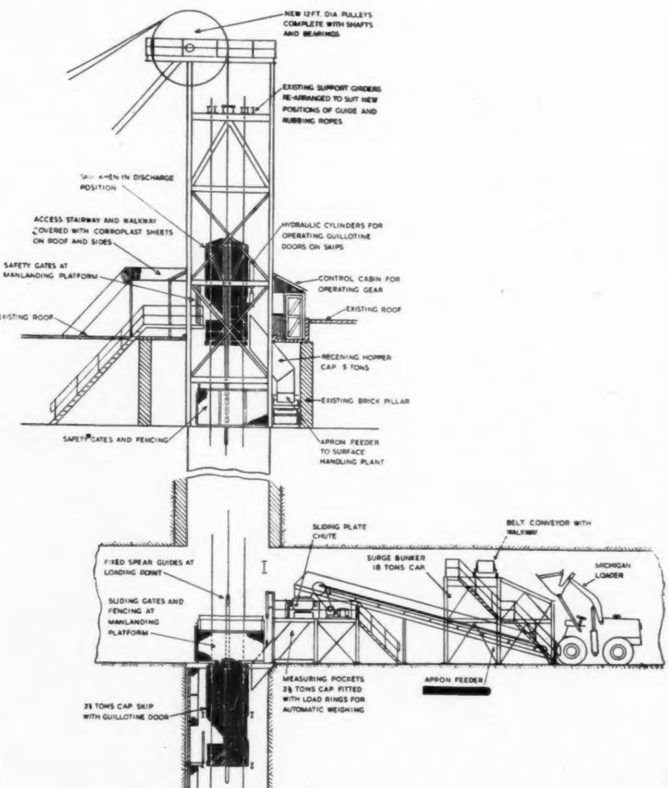
shovel and following further trials, in which it was found that these two types of machines made an ideal combination for trimming cargoes of iron ore to the square of the hatches, two Drott skid-shovels were also purchased. In certain vessels it is possible to employ the four machines at the same time.

When used as a dozer, the Anthony loader-dozer is useful for pushing ore from the long ends to the square of the hatch and, where two holds are not divided by a bulkhead, for pushing the ore from the smaller to the larger of the two holds. Used as an overloader the Anthony loader-dozer is very useful in tunnel holds and in other confined spaces where it is not possible for the machine to turn round. In this operation it throws the ore backwards from the wings and long ends.

The 4-in-1 Drott skid-shovel is used chiefly on backdragging and dozing, the other two movements of which the machine is capable being seldom used. It is the practice to put the Drott machine into the hold of a ship as soon as the ore within the square of the hatch has been removed by grab for a depth of about 7 ft. to 8 ft. Thereafter, the machine is used to drag the ore remaining heaped in the wings and ends into the centre of the hold within reach of the grab.

This procedure continues to the completion of discharge and it is now no longer necessary to employ shovelling and tubbing gangs.

J. Grindrod.



Skip Plant Arrangement at Winsford Salt Mine.

Modernization for a Salt Mine

A modern skip plant, it is announced, is to be installed in the Salt mine at Winsford, Cheshire. The plant to be put in, illustrated here, has been ordered by Imperial Chemical Industries Salt Division from Head Wrightson Stockton Forge, Ltd., and is intended to permit of much increased production from the mine. At present the salt from Winsford is sold to local authorities for snow clearance and the agricultural community. It is being mined from a depth of approximately 500 ft., the strata being 80 ft. thick, of which 20 ft. is extracted by pillar and stall mining.

To overcome design difficulties the skips to be employed will be constructed entirely of aluminium alloy and will have a payload capacity of 2·3 tons. They will be bottom-discharge type operated externally by hydraulic rams and fitted with a hinged deck to accommodate men when necessary.

An unusual feature incorporated on the measuring pockets is the use of electronic load rings for accurate weight assessment and the whole of the plant will be electro-hydraulically controlled, a modern control system which greatly reduces the number of operatives required.

Engineering Log

Australia's latest and largest blast-furnace, a major feature of the Port Kembla steel-works and forming part of the current development programme being undertaken in that area by the Broken Hill Proprietary Company and Australian Iron and Steel, has commenced production. The new furnace incorporates many new operational and design features and, with its ancillaries and blower station, has cost approximately £A10,000,000. It has a capacity of over 1,700 tons of pig-iron daily and will consume 1,750,000 tons annually of the essential raw materials—ore, coke, and limestone. The entire structure is welded and with refractories and mechanical equipment weighs 25,000 tons, the whole supported by a foundation of 26,500 cu. yd. of concrete and 1,633 steel piles. This furnace, together with the seven already operating in Australia, brings the Commonwealth's iron-making capacity to about 3,000,000 tons per annum, including about 1,900,000 tons from the Port Kembla works.

* * *

Woodworking plants of various types and particularly those whose business it is to manufacture furniture use automatic shaping lathes to turn simultaneously any portion for the length of a piece of work. This is achieved by means of a gang of specially-designed cutterheads on a staunch arbour shaft extending the entire length of the machine. The profile to be turned is incorporated into shear-cutting knives mounted on the cutterheads and the gang revolves at high speed. Another device used is the swinging carriage, with headstock and tailstock mounted in it. A turning blank can be advanced between centres towards the spinning cutterheads at a controlled pace by swinging the carriage and as the blank approaches the cutters it is slowly revolved on centres. A stop prevents the carriage advancing beyond a prescribed point. In this way turn diameters can be pre-set. Production is at a high rate and all turnings in a lot can be matched. A recent refinement of the unit described has been effected by using air power to operate the tailstock, carriage, and steady rests automatically, together with hopper feeding. Under these conditions the machines will accept turning blanks from $\frac{3}{4}$ in. to 4 in. square, varying from 30 in. to 42 in. long between different types of machine. The automatic setting and control of hopper feed rate and air-operated feed of carriage to cutterheads has increased the rate at which accurate work is put out. Longitudinal vibration has been checked by steady rests; where before rests were cam-operated the hopper-fed machines are equipped with pneumatic rests. In one instance the new machine produces 2 in. by 2 in. by 12 in. stock turned at the rate of seven pieces a minute, against two pieces per minute average on the manually-operated lathes.[1]

* * *

It was recently announced that a new mobile drilling rig, designed for drilling with $2\frac{7}{8}$-in. drill pipe to a depth of 2,500 ft., or to 4,000 ft. with $2\frac{3}{8}$-in. pipe, has been shipped from England to Libya, where it is to be used by BP Exploration Company. This is the first all-British designed rig of this capacity and mobility to be produced. To be known as the "Pilcon 2500", the new rig,

[1] *Comp. Air Mag.* May, 1959.

designed for use in difficult terrain, particularly in desert conditions, will be used in Libya for deep stratigraphical survey work. Before shipment it was tested in fields at Eakring, in Nottinghamshire. The rig, mounted on a truck with a 21-ft. wheelbase, has four heavy screw-down jacks, which fold clear when travelling, mounted on the chassis. The tubular steel mast, which is raised and lowered by hydraulic rams, gives 58 ft. clearance above the rotary tables and has a 60,000 lb. capacity. The double-drum drawworks are designed for a hook load of 35,000 lb. off the main drum and the rotary table has an 18 in. diameter opening. The mobile chassis also accommodates the mud pump, a hydraulic oil pump, a lubricating oil pump, two compressors, and a generator for emergency lighting. All units are remotely controlled from a convenient panel at the driller's position.

* * *

Canada has recently had the excitement of an oil rush, twenty large companies having applied for prospecting rights in the Arctic Islands. The possible existence of oil was first hinted at when studies of air photographs taken by the Canadian Air Force were made some four years ago. These disclosed significant rock formations west of Ellesmere. Heavy transport, aircraft, and equipment were flown in under wintry conditions and base camps were established. Caution was exercised while the question of sovereignty over the polar islands was considered, the Canadian claim being based on the "Sector Principle" by which the lines of longitude are taken as extending right up to the North Pole. This has now been supplemented by occupation on a permanent scale. Even after this there was the considerable difficulty of exploitation of any oil found while islands on which it occurred were permanently locked by sea ice. Not until the atomic submarines *Nautilus* and *Skate* had shown the feasibility of under-ice navigation did any project come within the realm of practical engineering. Recently plans have been put in hand for atomically-powered submarine tankers and freighters and these plans also include the creation of lagoons, which will be free from ice, where such ships can surface. It is at the moment proposed to keep the lagoons free of ice by using compressed air but more ambitious schemes are envisaged for the future for the same purpose.

The United States Bureau of Mines recently stated that laboratory studies have proved that internal heating of a cell used in electro-refining titanium is practical and offers several advantages over externally heated designs. In a report on its continuing research on titanium the Bureau said that successful studies with the improved cell have prompted its scientists to include additional experiments on internal heating in larger units. The Bureau's fused-salt electrolytic cell was externally heated and had a relatively short life because of deterioration of exterior walls. In quest of greater economies research workers devised an internal heating element which, in small-scale tests, not only operated more efficiently, but greatly reduced scaling of the cell's exterior.[1]

* * *

The United States Navy is developing an electronic computer (about the size of a biscuit tin) to allow one man to control the entire operation of a nuclear submarine. The new system of control, described in *Naval Research Reviews* in August, might allow a reduction in A-submarine crews from an average of 100 to as few as 12 men. The control staff for a submarine in World War II was eight men and the atomic submarine of to-day at present requires a team of three men to guide it. The new control system is known as SUBIC (Submarine Integrated Control). The controller, or commanding officer, will receive visual information from five different control systems—engineering, communications, weapons, environmental, and ship. These are the five systems used to-day to feed data to the dials on the instrument panels. The 40-lb. SUBIC computer, however, will dispense with dials and convert the data into simple television pictures.

* * *

At the recently held 9th International Botanical Congress in Montreal, a report was made on the ability of strong-looking timber to house spores of the fungus *Sporotrichum schenckii*. This fungus is an important cause of disease. In South Africa it was not until some 3,000 mine workers had developed sporotrichosis that the cause was recognized to be the apparently healthy and sound mine timbers, which contained the mature spores. The fungus causes skin lesions which

[1] LEONE, O. Q., and others. *Rep. Inv. U.S. Bur. Min.* 5494.

can spread along the lymph channels and affect internal organs and the bone itself. Dr. Rebecca Brown, of the Transvaal and Orange Free State Chamber of Mines in Johannesburg, reported that control measures taken had been successful, and had killed the fungus. Research showed that in older seasoned wood the disease-bearing fungus is eliminated by wood-destroying fungi which are commonly present in mines. The Congress also heard that Dr. T. Ohtsuki of Ochanomizu University, Tokyo, has discovered a means of saving photographers a great deal of trouble and expense from another tiny fungus which clouds lenses. The fungus can subsist on air and is therefore able to live on a lens, or on any other glass or metal surface, even when that surface is perfectly clean. The fungus is *Aspergillus glaucus* var. *Tonophilus* and Dr. Ohtsuki reported that under the microscope the outline of the rust is strikingly like the fungal mycelium. In answer to the photographer's and research worker's optical needs Dr. Ohtsuki has produced a chemical fuming substance, harmless to lenses, and able to keep glass or metal clear of the fungus for a period of 10 years without the expense of periodic cleaning.

* * *

Mining studies covering basic and applied aspects of rock fragmentation and ground support and metallurgical studies which emphasize recovery from oxidized ores and sulphide slimes will form the major part of the United States Bureau of Mines lead and zinc programme during the current year. The research, which is to be carried out at five experiment stations and several field offices, also includes a compilation of marketing practices in lead and zinc scrap and recovery procedures at secondary smelters, investigation and reporting of mining and milling methods and costs at selected plants, and statistical studies to provide facts regarding metal supply and demand which guide the intensity and character of industry and Government research. The workers in the Coeur d'Alene region of Idaho are to study rock pressures and ground support problems associated with deep mining. The effectiveness of precast, segmented, reinforced-concrete drive sets and the factors affecting hydraulic transportation and placing of stope fill will be tested and theoretical concepts will be reviewed. Laboratory work is also to continue in pressure digestion of oxidized lead and zinc ores and in the use of radioactive tracers to analyse results of leaching studies. Research also will continue on the flotation of oxidized ores of lead and zinc and slimed lead and zinc sulphides now discarded in mill tailings. Various reagents will be tested. These will include surface-active organic chemical as promoters. Synthetic organic polyelectrolytes and non-ionic flocculents will also be tested in connexion with flotation and in possible concentration of slimed sulphides in a hydraulic cone.[1]

News Letters

BRITISH COLUMBIA

September 8.

Geological Map.—Mr. R. A. Brooke, the Vancouver mapmaker, has released Geological Map No. 8,[1] covering all Canada north of the 54th parallel with the exception of a portion of Labrador, where it dips to 52° to provide continuity in showing the iron-bearing areas. Measuring 30 in. deep by 8 ft. in width, the huge map makes reference to geological reports dating from 1845 to as recently as August, 1959; the northernmost reference is at 85° on Ellesmere Island. In addition to the hundreds of geological reports identified, the source of other information is provided in an appendix.[2]

Cominco Iron and Steel Smelter.—The Consolidated Mining and Smelting Co. of Canada, Ltd., has let three contracts in connexion with the $20,000,000 iron and steel project at Kimberley. The erection of buildings and installation of equipment is to be carried out by the Foundation Company of Canada, Ltd. Sintering equipment will be supplied by Lurgi Gesellschaft, of Frankfurt, and the first electric pig-iron furnace will be supplied by Elektrokemisk, of Oslo. The two European firms performed the final test work for the electrothermic reduction process which will be instituted for the first time in North America at Kimberley. Work on foundations has already commenced and erection of buildings is scheduled for late autumn. It is hoped to install major equipment in the spring of 1960. The smelter, announced in April, will utilize iron tailing from the Sullivan mine to produce pig iron, steel ingots, and rolled-steel products at a planned capacity of more than 100,000 tons per year.

Alberni.—The Empire Development Co., Ltd., has negotiated a new contract with Japanese smelting and refining interests for the sale of 1,000,000 tons of iron concentrate of specified grade at $9·70 per ton, an increase over the $8·25 received under the previous contract which has not yet been filled. To date approximately 80,000 tons of concentrate have been shipped in 1959.

Development work on the copper prospect of the Mt. Washington Copper Co., Ltd., has been suspended by Noranda Exploration Co., Ltd., until

[1] *U.S. Bur. Min. M.M.S.* No. 2958.

[2] Map No. 8 is available at a cost of $40 on application to R. A. Brooke, 228–736 Granville St., Vancouver 2, B.C.

the base-metal rights on the Mt. Washington mineral claims have been more clearly defined. Negotiation is now in progress with the Esquimalt and Nanaimo Railway Co. to clarify security of tenure.

Victoria.—The July production of Cowichan Copper was 690 tons of concentrate grading 28·63% copper from 7,600 tons of ore grading 2·72% copper. In the full 19 months of operation to July 31 last Cowichan has treated 146,137 tons grading 3·06% copper with the efficient recovery of 96·39%. Shipments have aggregated 14,880 tons of concentrate containing 8,368,863 lb. copper and 44,377 oz. silver with a gross value of $2,402,607.

Vancouver.—Norco Resources, Ltd., a recently incorporated B.C. company, is constructing a road from Theodosia Inlet, 25 miles north-east of Powell River, to reach the Copper King prospect of 66 mineral claims. As soon as access is established it is planned to commence an underground development programme. Surface work has exposed several occurrences of high-grade copper mineralization. The company is capitalized at 5,000,000 shares of which 900,000 shares have been issued for properties.

New Westminster.—Giant Nickel Mines has negotiated a three-year contract for the sale of nickel concentrate to Sumitomo Shoji Kaisha, Ltd., after discussion and investigation extending over six weeks. The first shipment is scheduled for February, 1960, by which time the existing contract with the Fort Saskatchewan refinery of Sherritt Gordon Mines is expected to be filled. In announcing the deal, Mr. W. Clarke Gibson, the president of Giant Nickel, pointed to some advantages that have been provided by the Japanese interests when compared with purchase offers from United States or Canadian firms. These include a slightly higher price for contained metal, a material reduction in freight expenses, and, notably, acceptance by the purchaser of a 10% moisture content, a condition which relieves the shipper of the present filtering process and the additional cost thereof. The Giant Nickel mill is at present treating 800 tons of ore daily and the company expects to increase the rate to 1,000 tons during September.

Kamloops.—Rio Tinto Exploration has acquired an option to take control of Trojan Consolidated Mines, whose property is situated in the Highland Valley. A geophysical survey is being conducted and if the results provide warrant diamond drilling and underground development will follow. Should all options be exercised and the property brought to the production stage, both Rio Tinto and Trojan will be repaid for expenditures and profits will then be divided 80% to Rio Tinto and 20% to the vendor.

Alscope Explorations, Ltd., has been granted registration by the Securities and Exchange Commission of the United States authorizing Investment Brokers of New Jersey Inc. to sell 685,000 Alscope shares. Alscope holds two large claim groups in the Highland Valley on which geophysical surveys have been made and drilling is scheduled to follow. The company is also conducting exploratory work on two groups comprising uranium prospects in northern Saskatchewan under the direction of Mr. B. C. Macdonald, the consulting engineer. Reports of an iron discovery on the north shore of Burrard Inlet are of particular interest to Alscope for the location is on a claim adjoining the company's Lynn Creek zinc deposit and any work done may help to obtain improved transportation, which has been a deterrent factor in the past history of the property. Various royalties and interests in petroleum and natural gas leases have been purchased in Alberta and the company is participating in the drilling of two wells. Alscope has large oil interests on Graham Island and is hopefully awaiting results from the geophysical and drilling programme being conducted by Richfield Oil Co. in that area.

Greenwood.—Consolidated Woodgreen Mines commenced milling ore from representative ore blocks on July 23. The mill had been in operation for some time prior to that date, but had treated only such marginal material as was encountered in preparing the open pit for steady mining. The current rate of 600 tons daily will be increased to full capacity of 1,000 tons as the reserve is opened. The mine manager estimates 330,000 tons averaging 1·4% copper to be available to the old 200 level, with 70,000 tons in another block. Continuous diamond drilling has encountered several very encouraging intersections, probable ore being estimated at 4,000,000 tons.

A special meeting of shareholders of the Continental Mining Corporation has been called to consider a proposal for re-organization, in order to acquire all assets of Columbia Copperfields, Ltd., including the Brooklyn-Stemwinder and Rawhide groups at Phoenix. The Brooklyn claim has a recorded production of 319,320 tons of ore containing 27,374 oz. gold, 109,832 oz. silver, and 7,800,000 lb. copper. Columbia Copperfields has expended some $200,000 on drilling of the Stemwinder which has defined a reserve estimated at 200,000 tons recoverable by open-pit mining. The Rawhide claim has produced 943,180 tons of ore containing 33,941 oz. gold, 222,149 oz. silver, and 18,610,304 lb. copper.

Camp McKinney Gold Mines plans to commence shipments to the Trail smelter by mid-October at the rate of 50 tons of hand-sorted ore daily. The silica content of the ore, amounting to 80%, is expected to contribute about $3·50 per ton to smelter returns owing to its special value as flux. The company is capitalized at 3,000,000 shares of which 900,000 shares have been issued for properties. Operating capital of $100,000 has been subscribed by Giant Mascot Mines, Ltd., Mt. Washington Copper Co., Ltd., and two individuals for a 40% interest.

Golden.—During the fiscal year ended May 31, 1959, Sheep Creek Mines produced 144,184 oz. of silver, 7,509,673 lb. of lead, 18,460,782 lb. of zinc, 30,464 lb. of cadmium, and 937 tons of barite from 190,770 tons of ore grading 2·36% lead and 5·45% zinc. A net profit for the year of $222,554 was earned. Ore reserves at the year-end were estimated at 315,752 tons averaging 2·49% lead and 4·89% zinc with 1·0 oz. of silver per ton. Sheep Creek carried out considerable exploration on the La Reforma property, in Mexico, resulting in the indication of more than 1,000,000 metric tons of ore of excellent grade in silver, lead, zinc, and copper. The company is confident a milling plant will be erected within a year and that the mine will by that time be sufficiently developed to maintain a steady profitable operation.

Yukon.—The gold production of the Yukon Consolidated Gold Corporation, Ltd., for 1959 to the end of July has been estimated at $747,100. This compares with $768,000 at the same time in 1958.

Mexico.—Colossus Nickel Development, Ltd., has encountered a setback due to torrential seasonal

rainfall in its programme of unwatering the Promontorio mine, at Alamos. The seepage through old glory holes has been so great that the pumps have been able only to hold their own some 40 ft. above the No. 2 level, principal objective of the programme. Old records disclose this to be the last horizon opened by John Taylor and Sons, of London, before suspending operation in 1898, at which time indicated reserves were estimated at approximately 200,000 tons carrying some 60 oz. silver per ton. An increasing content of lead, then severely penalized, was a factor in the decision to close the operation. Colossus has continued shipping ore from reclaimed stopes on the main-haulage level and has shipped 10 cars to smelter with 250 tons currently stockpiled at the portal. The average grade of this ore is 20 oz. silver and 0·12 oz. gold per ton, with 3·0% copper, 4·0% lead, and 6·0% zinc. The company does not receive smelter returns for the lead and zinc and is therefore anxious to hurry the erection of a concentrator. The size of plant will be determined after ore on the No. 2 level has been appraised.

EASTERN CANADA

September 20.

Porcupine.—In order to provide two new levels below the 23rd level, the present bottom, Hallnor Mines is to take its inclined winze down an additional 300 ft. Ore of better than average grade has already been opened on the 23rd level, it is stated, while drilling below that horizon has given favourable results. In the first half of the current year the company earned an estimated net profit of $223,200.

North-Western Ontario.—It is announced that Castlebar Silver and Cobalt has exploration work already under way on its newly-acquired holdings in the Shonia Lake area of the Red Lake Mining Division. Contained within five-claim groups embracing a total of 103 claims, the Castlebar ground was selected following results of an airborne electromagnetic and magnetic survey recently made of the area. A series of strong anomalous responses were obtained on each of the five-claim groups. Ground surveys have progressed to the stage where some targets are now being diamond-drilled. Ground-survey and geological-mapping results to date have been particularly encouraging. In the Gowganda silver camp the company is continuing a programme of exploration diamond-drilling and surface work on its 28-claim holding neighbouring the Castle-Trethewey and Sisco mining developments.

Manitouwadge.—Willroy Mines, whose results for 1958, its first year of production, were referred to last month is to increase its daily crushing rate from 1,000 tons to 1,200 tons. The new capacity will be needed to treat copper ore from the new No. 6 orebody as well as similar material from the original No. 1 zone. Such ores should soon total about 300 tons a day and average around 3% copper.

Manitoba.—The shaft at Bernic Lake having been deepened to 325 ft., Montgary Explorations, Ltd., is to explore a deposit of pollucite (a hydrated silicate of aluminium and caesium) indicated by diamond-drilling. It has been stated that in course of shaft sinking important tantalite-columbite values were encountered.

A company called Canorama Explorations, Ltd., is planning a drilling campaign over a nickel occurrence in the Mystery Lake–Moak Lake area. A geophysical survey completed earlier this year was considered favourable.

Quebec.—Last month Aluminium, Ltd., announced that the current rate of production of its Canadian aluminium smelters was to be increased by 33,000 tons per year through the re-activation of certain idle facilities at Beauharnois, Quebec, and Kitimat, B.C. The present rate of production of all the company's Canadian smelters is 500,000 tons per year out of an annual capacity of 770,000 tons. The decision to increase production is dictated, it is stated, by the gradually improving tone of business in North America, the United Kingdom, and other overseas markets.

In the report of Placer Development, Ltd., for the year to April 30 last shareholders are reminded that in May, 1958, an agreement with the Mattagami Syndicate was entered into by Canadian Exploration, Ltd., Noranda Mines, Ltd., and McIntyre Porcupine Mines, Ltd., each of the three companies sharing equally in the right of a 66·6% participation in Mattagami Lake Mines, which has discovered a substantial zinc-copper deposit on its property in the Mattagami Lake area. From drilling results to date an ore-body in excess of 20,000,000 tons is indicated, averaging about 13% zinc, 0·7% copper, 0·02 oz. gold, and 1·3 oz. silver per ton. Diamond-drilling continues and engineering studies are being made of the venture, the report states.

In the Chibougamau area the Bateman Bay Mining Company, according to the report for the year to March 31 last, has now finished the shaft-deepening programme and is rapidly developing two new levels at 375 ft. and 500 ft. It is also stated that an agreement regarding the milling of Bateman ore has been concluded with the Merrill Island Mining Corporation.

The Province, it has been announced, has had a total of 56 projects in its record summer programme of geological investigations. The Geological Surveys Branch, making regional investigations, has 23 projects under way. In the far north two parties are in the Cape Smith–Wakeham Bay belt, just south of Hudson Strait, and one is east of Fort Chimo, near the head of Ungava Bay. In Saguenay county, there are four parties in or near the Mount Wright–Mount Reed region, north-west of Seven Islands, where preparations are being made for large-scale iron mining, and two parties farther east, adjacent to the lower north shore of the St. Lawrence. Special attention is being given to the country west and south-west of the Mattagami Lake region where in the last year important discoveries of copper and zinc have been made.

AUSTRALIA

September 20.

Iron Ore.—Two important objectives in Australian mining are the search for iron ore and oil. The Tasmanian Government aims at a State-owned iron and steel industry and has been carrying on drilling in the north-west of the Island on deposits at the Savage River and Long Plains. The former occurrence is large, but the grade is such that beneficiation would be needed to raise it to smelting tenor. The tonnage available is insufficient to warrant the capitalization that would be involved in the enterprise. Long Plains is in the same locality and the deposit was located by geophysical survey. Drilling

has been transferred to this area from the Savage River and no particulars of the work and results have been announced. Apart from the matter of ore reserves difficult problems are presented by the remote and rough locality, consequent transport difficulties, and their incidence in establishing an industry on or near the field, should adequate ore reserves be proved. Should tonnage be insufficient the alternative of export to the mainland iron works is faced by the difficult and costly transport problems.

In North Australia the Broken Hill Proprietary Co. has been carrying on energetic prospecting on the Cape York Peninsula and the Northern Territory. Discovery of a large iron-ore occurrence at the mouth of the Roper River has recently been announced by the Territory Administration and may prove a substantial addition to the Commonwealth reserves.

The rapidly-increasing demand for iron and steel in Australia is such that export of ore seems to be a very undesirable policy. The State Government is drilling at Tallering Peak and work on other occurrences will be considered. Overseas interests have taken an option over an iron occurrence at Mourilyan, in Queensland and prospecting work is to be commenced.

The Government of Western Australia has had numerous applications for the right to obtain iron ore from the deposits in the State. For some time past the rich and large occurrence of high-grade ore at Yampi (in the Kimberleys) has been shipped to the Eastern States for Broken Hill interests ; the ore approximates 62–63% Fe and tonnage produced to date is in excess of 3,000,000 tons. In more recent years, since the development of a charcoal-iron smelting industry at Wundowie (50 miles east of Perth), a considerable tonnage of iron ore from Koolyanobbing has been railed from the town of Southern Cross to the works. The amount used to date exceeds 300,000 tons ; the ore grades about 61–62% Fe.

The State Government now announces a scheme of calling for tenders from possible purchasers ; either of ore from Koolyanobbing and shipment at Fremantle, or from another deposit near to Port Hedland (in the north-west), at the Ellarine Hills. " Inquiries have been persistent in recent months ; the only way to clarify the real demand and market prospects is to permit all interested parties to submit a proposition to the Government." At the moment it has been suggested that tenders close on November 30 and applicants must establish their bona fides by submitting a bank guarantee of £10,000 with their tender and, if successful, to deposit £100,000 as security for the carrying out of the contracts. It is proposed that from Koolyanobbing an amount of up to 5,000,000 tons be made available and from Ellarine Hills up to 10,000,000 tons. The State Government then expects to make application to the Commonwealth Government for the right to export the ore tendered for.

Should either or both of these propositions be successfully taken up it would then be possible to extend the schemes, for there are several very large deposits of iron ore of good grade in accessible areas in the State, one of which—Tallering Peak—is considered to be within quite handy reach of the port of Geraldton.

Oil.—Search for oil is being pushed on actively, but with little actual encouragement. West Australian Petroleum, Ltd., has spent £A15,000,000 on the search in Western Australia. The Royal Dutch Shell group is interested to the extent of £A1,500,000 in West Australian Petroleum and finance is considered sufficient for exploration until February next, after which additional capital must be provided. The company will derive benefit from the Commonwealth Government's subsidy for oil exploration.

It is reported from Sydney that the Phillips Petroleum Co. of U.S.A. proposes to spend £A670,000 on oil and gas exploration in Australia this financial year. Headquarters have been established in Brisbane and it is intended to commence drilling between Charleville and Quilpie, in south-west Queensland, within 12 months. Geophysical work is to be commenced for the selection of drill sites. Concessions in which the company is interested cover 41,400,000 acres in Queensland.

Oil Drilling and Exploration, Ltd., is to commence drilling for the Frome-Broken Hill Co. Pty., Ltd., at Port Campbell, in southern Victoria. Exploratory drilling is expected to reach a depth of 6,000 ft. The area held by the company is 4,000 sq. miles. Geological and geophysical parties have been working in the area for three years.

Coal.—Re-organization and mechanization of the coal-mining industry have now placed the industry on a sound footing and re-established to some extent the lost export trade. This work and the essential reduction in costs which is inseparable from the re-organization of the industry have naturally caused dismissals of labour to keep production within the limits of available markets. This problem is under consideration by a special committee. Proposals to be investigated bearing on expansion and the future of the industry include : Construction of gasworks on the coalfields ; establishment of chemical industry based on coal ; rehabilitation of depressed areas on the coalfields by the establishment of suitable industries ; the future of the Joint Coal Board, which has done good work in the reconditioning and revival of the industry ; the establishment of a State Coal Board or authority to take the place of the Joint Coal Board. This may be considered a retrograde step in view of the successful record of the present Board and increase in Government control in the industry is undesirable. Members of the committee are members of the State Parliamentary Labour Party. It is unlikely that support will be given by the Commonwealth Government, which is an important member of the existing Board.

Bauxite in New Zealand.—The Rio Tinto group has applied for bauxite prospecting rights over two areas near Whangarei. The applications are over small areas, but negotiations are in progress covering larger fields. Much prospecting will be necessary, requiring considerable time, before the economic possibilities of the areas would be known. There is optimism as to large tonnages, but nothing comparable to the North Queensland occurrences is anticipated. The occurrences are easily accessible and work by the Geological Survey of the Department of Scientific and Industrial Research has found low-grade ore covering large areas. Search for high-grade occurrences is proceeding.

Uranium.—A recent statement by the Minister for National Development forecasts that all productive capacity of uranium mines will be needed by the 1970's to provide fuel for power stations. At the present time uranium sales are entering a slow,

difficult period, with falling prices. Australian producers have sold all their output to the combined Development Agency and to the United Kingdom Atomic Energy Authority, the last of which contracts would be completed by 1966. The Rum Jungle contract will expire by the end of 1962 and Australia will then have sufficient proved reserves to meet its own foreseeable needs until about 1980. As it is desirable to maintain an active mining industry it might be necessary to help producers to find overseas markets if their output should not be immediately required in this country. At present there is little or no interest in uranium prospecting by other than established interests.

Gold.—The position of this branch of the industry is not very encouraging, with the static price for gold and steadily rising production costs. Western Australia maintains a fairly steady rate of production, but conditions are adverse to increase in ore reserves and favour rather the working of higher grade ore to maintain a margin over costs. That there is little, if any, tendency in this direction is a tribute to the efficiency and able management of the industry, as instanced mainly by the Western Australian mines.

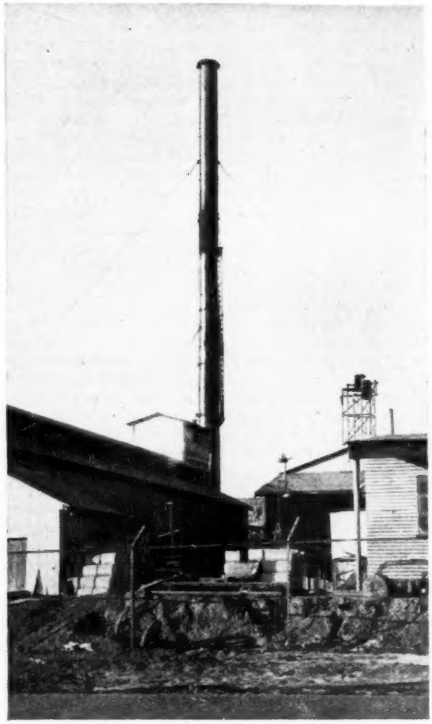
Queensland has reported improved production in the six months ended June 30, an increase of 12,045 oz. to 47,734 oz. for the period, for which Mount Morgan was largely responsible.

In Victoria the industry is steadily becoming worse. The Morning Star mine, a steady producer over many years, is closing down because of very disappointing results of development between No. 19 and No. 24 levels. There will then remain only two producing gold mines in a State that was a noted gold producer. The gold yield for the month of July was 3,578 fine oz., a decrease of 866 oz. For the seven months to July 31 of this year the State production was 21,149 fine oz., a decrease on the corresponding period of 1958 of 3,501·8 fine oz. This position will deteriorate further in the immediate future.

In the Northern Territory the position, depending upon the Tennant Creek goldfield, is stable. Encouraging drilling results by the Peko company on the western part of the field indicate a possible new producer if these results are confirmed by underground development to be carried out from the shaft now being sunk.

In Western Australia the State Government is giving useful assistance to the industry. Late advice is that the Government is taking steps toward possible renewal of interest in the once important Meekatharra field. Diamond drilling is to be done on an area known as Paddy's Flat, with the objective of intersecting at depth, a possible repetition of the Fenian, Consols, and Marmont ore-bodies north of the old workings and on the line of pitch. These mines were the big producers in their day, but work in the Consols ceased at a depth of 1,200 ft. because the grade of ore was insufficient to compensate the rising operating costs and the static price of gold. In the case of the Fenian and Marmount the pitch of the shoots had taken them into the Consols property.

Western Australia.—A preliminary report on operations by Great Boulder Gold Mines for the year to June 9, 1959, shows that 507,096 short dry tons of ore were treated for the recovery of 124,684 fine oz. of gold ; silver recovered amounted to 32,678 fine oz. The head value of the ore per short ton was 5·38 dwt. and net proceeds of bullion



New Stack at North Kalgurli.

£A1,961,017. The net profit from all sources was £A274,113. Ore reserves were estimated at 2,009,400 tons with an average grade of 5·55 dwt. gold per ton. Development footage was well maintained at 14,289 ft., but diamond drilling, 4,873 ft., was less.

Gold Mines of Kalgoorlie (Aust.) Ltd. shows a revenue of £A2,509,694 for the year to March 31 as compared with the previous year's revenue to £A2,544,036. Gold returned £A2,192,191 and the Commonwealth subsidy £A313,632. The ore treated totalled 531,959 tons, as compared with the previous period's 520,328 tons. Gold recovered was 142,584 oz.

Central Norseman Gold Corporation maintained its leading position amongst Western Australian mines in the last financial year, reporting a profit for the year to March 31, 1959, of £A759,227. Revenue increased from £A1,505,859 to £A1,724,958. The mill treated 190,150 tons of ore for the recovery of 109,801 fine oz. of gold. Ore reserves were estimated at 592,000 tons with an average value of 9·2 dwt. per ton. Underground development has been very consistent in both the Phoenix and Princess Royal sections.

At the treatment plant of the North Kalgurli (1912) the old smoke stack has been removed and the new, and much higher, stack came into operation early in September. The old stack at the Croesus

plant was only 80 ft. in height and complaints about fumes, etc., have been common over the last few years. Mainly local material was used in the construction of the new stack—chiefly in the shape of old and now unwanted boiler components. The new stack stands at a height of about 140 ft. The increased draught is likely to do something to improve the throughput and the extra height may do a little towards better distribution of the sulphur fumes and so lessen the complaints. Other smoke stacks for the same purpose on the Golden Mile approximate 200 ft. in height and serve to distribute into the atmosphere a total of about 50,000 tons of sulphur per year—from the roasting of flotation concentrates.

The latest copper producer in Australia is Ravensthorpe Copper Mines, in Western Australia, which has re-opened the old group of mines at that locality. After a long idle period diamond drilling for uranium at the copper lodes indicated extensions of these ore-bodies which were considered to warrant working at the prevailing prices for copper. Underground development has since proved encouraging ; a concentrating mill has been erected with a throughput of 6,000 tons of ore per four-weekly period. It is reported that ore has been exposed in the Elverdton-Desmond mines for a length of about 682 ft. ; maximum width is 12 ft., with a mean width of 8 ft., and average grade is stated to be 2½% copper. Deepest workings in the group are 500 ft. Concentrates are smelted in New South Wales, but Japanese interests are negotiating with a view to buying into the company.

FAR EAST

September 12.

Tin.—Tin circles in the Federation of Malaya have welcomed the International Tin Council's increase in the tin export quota for the last quarter of 1959, which means that Malaya's exports for the last quarter will go up to about 11,324 tons of metal. More Chinese mines will be able to re-open, and European mines will have longer hours of work, thus providing more employment. Sir Douglas Waring, a leader in the tin industry, said in Kuala Lumpur : " We have been through a bad time. The increased export quota is most welcome. It is the silver lining in the dark cloud." Sir Douglas said at the annual meeting of Kuala Kampar Tin Fields, Ltd., in Kuala Lumpur : " It is now fairly evident that world production should have been cut back by the middle of 1957 at the latest, but under the terms of the International Tin Agreement this was not possible until 10,000 tons of metal had been acquired by the Buffer Stock manager or at least were in sight. . . . The agreement itself was the outcome of prolonged negotiation over a lengthy period, and this particular feature represented a compromise of various views. In practice it has proved to be analogous to the situation which would arise if a railway driver was precluded from applying the brakes until his train was already dangerously out of control. . . . Coupled with this position was the sudden and subsequent continuous offerings of tin on the London market by the U.S.S.R. It is now apparent that the U.S.S.R. imported large quantities of tin from China which according to the U.S.S.R. official publication of statistics of foreign trade were 15,700 metric tons in 1956 and 22,000 metric tons in 1957. No figures for 1958 are yet available."

Sir Douglas also said that an international conference to consider a new tin agreement is to be held next May in New York. The present agreement will expire in June, 1961.

Malayan Tin Dredging has put into operation for the first time a new \$(Malayan) 8,000,000 dredge on its mining property near Tanjong Tuallang, 28 miles from Ipoh. This dredge, which is expected to last for some 30 years, was planned several years ago. Construction work, however, did not begin until early in 1958. The 296-ft. long dredge is capable of digging to a depth of 130 ft. and its rated capacity is 400,000 cu. yd. a month. Under the international tin restriction scheme the dredge will have a special quota for a year and then a fresh assessment will be made for it.

At the annual meeting of the F.M.S. Chamber of Mines, held in Ipoh, Mr. Delmè-Radcliffe, the new president, drew attention to the diminishing tin ore reserves and to the plant already lying idle. He said : " It might be thought that under the acute restriction of production that exists at present, the matter is no longer urgent. There could hardly be a greater blunder than to think so. Even under restriction the unceasing and relentless diminution of reserves continues."

Bauxite Production.—The Federation of Malaya's bauxite production during the first five months of this year amounted to 145,546 tons, an increase of 47,384 tons over the corresponding period of 1958. This rise was because Japan was buying more. In the five-month period of 1959 she purchased some 136,000 tons from Malaya, compared with 67,000 tons during the January–May period of 1958.

Borneo.—Mr. Mitzuso Kinno, a director of the Teikoku Oil Co., Ltd., of Tokyo, member of a Japanese industrial mission surveying development prospects in North Borneo, recently visited the neighbouring state of Brunei to test the possibilities of exporting liquefied gas from the Seria oilfield to Japan. He said that Japan was interested in importing such gas to assist her chemical industries and was prepared to transport the gas in her own ships. He was arranging to have talks with officials of Brunei Shell Petroleum Co., Ltd. Mr. Kinno also said that his company was interested in obtaining oil and gas concessions in North Borneo and he hoped permission would be obtained for exploratory drilling there.

The new mobile drilling barge, the Orient Explorer, which will be used by the Shell group of companies to search for oil under the bed of the South China Sea, arrived recently at Seria, Brunei, from the United Kingdom. The barge's first drilling location will be off the Seria coast in the Anduki area. The Orient Explorer generates her own power. She is completely self-contained and has a built-in helicopter landing stage.

" Small oil shows " have been found at shallow depth at Engkabang, in the Marudi district of Sarawak. The significance of the shows cannot be assessed at the present stage and drilling would continue to a depth possibly in excess of 10,000 ft.

An exploration well drilled by the Shell Company of North Borneo in an operation on Mengalum island costing \$(Malayan) 1,000,000 has been abandoned. The well was drilled to a depth of 7,000 ft. and the geological objective was reached but no commercial oil prospects were uncovered.

Noteworthy advances in the development of British Borneo's mineral resources in 1958 were the start of bauxite mining in western Sarawak and the commencement by a London mining company of chromite prospecting in North Borneo. This is stated in the British Borneo geological report for last year. It said discoveries which would help road development were the finding of granite at Bukit Piring in stone-short central Sarawak and of several million cubic yards of accessible gravel and cobble beds in Brunei.

SOUTHERN AFRICA

September 25.

Nuclear Energy.—An administrative tug-of-war over the delegation of responsibility for an intensified programme of research into nuclear energy, its application, and for initiation of investigation into methods of improving the recovery and refining of uranium oxide, has been resolved by assigning this responsibility fully to the South African Atomic Energy Board. Recently a consultant expert on the recovery and refining of the oxide was appointed to the Board, one of whose immediate projects is the purchase overseas of a research-reactor to be installed in the Southern Transvaal, at a site accessible to all the three universities in the Province, which are Pretoria, Johannesburg, and Potchefstroom. The installation is expected to be ready for use within about two years. In addition to the training of nuclear scientists within the country the Board has sponsored the training of 14 overseas and is arranging for the training of an additional 20 this year. The application of nuclear energy within the country, especially in the form of generating electric power, is receiving the Board's close attention.

Health Survey.—Dr. J. H. G. van Blommestein—medical consultant to the Anglo American Corporation group—in his comprehensive report for 1958 has commented that, while the general standard of health of African natives employed on the group mines has shown little change over the past five years, enteric fever, practically non-existent for many years, was gradually making its re-appearance in the gold mines and collieries, notwithstanding a full prophylactic vaccine course. This is attributed to the condition that the vaccine is not affording the protection which it gave in the past. Respiratory diseases (including pneumonias, influenza, and bronchitis) still take the greatest toll in sickness among the native employees. In the Free State mines there had been an overall increase in the rates, but on the older mines the incidence of lobar- and broncho-pneumonia was more or less unchanged. One of the many factors influencing this rate was that the Free State mines of the group had a much greater percentage of labour drawn from the tropical areas to the north. The Medical Committee of the Chamber of Mines has agreed in principle to the establishment of a rehabilitation centre for mine native paraplegics. It now remains to implement this agreement in the best possible manner. Throughout 1958 malaria on the Copperbelt of Northern Rhodesia was very satisfactorily controlled within the controlled areas; only two cases were reported—at Rhokana. The increase in the number of cases admitted to hospital from the mining and non-mining population arose from outside the controlled areas. Replacing D.D.T. and gammexane, dieldrin was proving very satisfactory.

The collieries of the group in 1958 had the lowest lost-shift rate arising from accidents since 1944, while the death-rate also decreased. There were 67 fewer deaths due to accidents than in 1957, in respect of the overall total for all mines of the group, while the figure for the reef and Far West Rand gold mines was almost halved. The prevalence of accidents increased on all gold mines but the lost-shift rate decreased, which indicated that the accidents which had occurred were generally of a less serious nature.

Export Coal.—The mission which recently visited South America to investigate the prospects of selling coal there has apparently not found conditions very favourable. The reasons reported by the mission on its return are: An acute shortage of foreign exchange being experienced by the South American republics; progress achieved by these countries, particularly in the Argentine, in supplying their own requirements of fuel, from domestic resources of oil, natural gas, and, despite its inferior quality, of coal which is blended with imported coal—mainly from Poland and the United States. South African coal was found to be of not sufficiently high grade to facilitate blending with domestic production. Furthermore, there is no reciprocity of trade between most of the South American republics and South Africa. However, since South African coal is attractively cheaper than coal imported from other areas, interest was aroused, but this is unlikely to be translated into actual sales unless the internal financial positions of most of the South American countries undergoes a radical change or reciprocity of trade can be negotiated, particularly for such South American products as coffee, timber, nuts, and oils.

Gold Certificates.—In association with Engelhard Industries of Southern Africa, Ltd., the French Bank of Southern Africa, Ltd., is formulating plans for the sale of gold certificates against dollars. The certificates will be exchangeable or convertible into gold, that may be deposited with the S.A. Reserve Bank or elsewhere. These plans are an extension of the channels of gold sales or selling through the Reserve Bank and the Chamber of Mines to private buyers outside the sterling area.

Rooderand Main Reef.—Rooderand Main Reef Mines, in the Anglo-Transvaal group, is the object of a take-over bid by Middle Witwatersrand (Western Areas), in the same group. The Rooderand company is participating directly and indirectly in the flotation of the new mining company, Western Areas Gold Mining, which will be administered by Johannesburg Consolidated Investment. As part of the arrangements for the take-over Rooderand's substantial shareholding in Freddies Consolidated Mines will be distributed among the former's shareholders. The Rooderand's interests, shareholding and exploratory within the Union and the Central African Federation, are largely complementary with those of the Mid. Wits. company. Its liquid resources are limited. Consequently, it can be active in the investment field only at the expense of its exploratory interests, and *vice versa*. It is therefore considered more beneficial to both companies—Mid. Wits. is a substantial shareholder in Rooderand—that Rooderand should become a wholly-owned subsidiary, in effect, of the Mid. Wits. company, which

has considerably greater resources and backing and is currently active in the exploratory field. One Mid. Wits. share will be exchanged for five Rooderand shares. At June 30, 1958, Rooderand's principal shareholdings were in Anglo-Transvaal Consolidated, Eastern Transvaal Consolidated, Freddies Consolidated Mines, Hartebeestfontein, Riebeeck, and Mid. Wits. itself. Its participation and exploratory interests included mineral rights adjoining the Riebeeck and Freddies Consolidated mines, and adjoining the southern boundaries of Saint Helena and Presidents Brand and Steyn and, jointly with Anglo-Transvaal's other associates, in various copper, chrome, nickel, and other prospects in Northern and Southern Rhodesia. Rooderand's current assets were last valued at £110,271, which imposed considerable rigidity on its activities.

Transvaal.—Financial arrangements for the two new mines in the Kinross area of the Eastern Transvaal, adjoining the Winkelhaak mine, are expected to be announced shortly. It has been reported that shaft-sinking is to be initiated in the near future. The two mines will be named Bracken and Leslie.

The lease formula for Western Areas Gold Mining indicates that the mine will be medium grade. This appears to be confirmed by the drilling results within the area, which results indicated an overall average of about 6·2 dwt. over 60 in. or 372 in.-dwt., with the results on the shallower Ventersdorp Contact Reef (2,642 ft. to 6,251 ft.) averaging about 7·1 dwt. over 60 in. or 426 in.-dwt. and on the deeper Elsburg Reefs about 5·9 dwt. over 60 in., or 353 in.-dwt. Indicated overall payability is about 66%, that on the Ventersdorp Contact being about 50%, and that on the Elsburg Reefs about 70%. Owing to the multi-banded Elsburg Reefs the unit tonnage will be high and these reefs will contribute most of the mill tonnages. The lease area of 2,230 claims is relatively small by modern standards, but the high unit tonnage is expected to yield a total of 68,000,000 tons with an average expected sampled value of 9·3 dwt. over 60 in., or 558 in.-dwt. The general dip of the formations is southwards and relatively flat and appears to be relatively undisturbed by faulting. Water, however, is expected to be encountered. While the drilling results suggested a falling-off in grade outside the limits of the lease area provision has been made for extending the boundaries in due course in the light of underground development results, which may indicate that extension outside the lease area will be mainly on the Elsburg horizons. Sinking the twin-shaft system should be in progress by early 1960. The hoisting component, 26 ft. lined diameter, will be sunk to a depth of about 4,850 ft. and has a hoisting capacity sufficient to supply the mill with 200,000 tons a month. The ventilation component will be sunk to a depth of about 3,500 ft. Initial production at a milling rate of about 50,000 tons a month is expected to be attained by 1963-64 in a Randfontein plant to the north. The mine will later be provided with its own plant with an ultimate capacity of 200,000 tons a month. To bring the mine to production at 50,000 tons monthly estimated expenditure of £7,000,000 will be subdivided as to shaft-sinking £2,200,000; shaft equipment £770,000; development £1,000,000; underground equipment £610,000; housing and accommodation £670,000; power, compressed-air, and other services £420,000 and the balance on stores and general expenditure, etc.

New Consolidated Gold Fields has taken up options over about 86,400 claims immediately south of the line of mines Libanon westwards to Doornfontein and the zone of mineral rights south of these mines, which rights are held mainly by West Witwatersrand Areas, Western Ultra Deep Levels (an Anglo American Corporation subsidiary), and Witwatersrand Deep (which, as a company in the New Union Goldfields group, will pass to the New Consolidated Gold Fields group). The western limit of the options now taken up by New Consolidated is the Mooi River, in the vicinity of which West Witwatersrand Areas, jointly with New Central Witwatersrand Areas, has been patiently drilling for some considerable time. Drilling operations in the new option area will be initiated by New Consolidated in the near future, the programme of exploration aiming at establishing whether the economic reef horizons mined by the currently operating companies to the north occur and, if so, at mineable depths. Those reefs are the Ventersdorp Contact, the Main, and the Carbon Leader reefs. The option area is thought to lie completely, or almost so, below the overlying Transvaal System of dolomites and lavas, but may be upcast by faulting to economic depths. There are no outcrops in the area. The only extensive outcrops of the Upper and Lower Witwatersrand Systems occur further south in the vicinity of the Vaal River and the town of Parys, on the northern rim of the Vredefort boss of granite, where in the more distant and recent past fairly extensive prospecting and sporadic productive operations have been conducted with varying results.

Natal.—A further outlet for the production of ilmenite concentrates by Umgababa Minerals, Ltd. (of the Anglo American group), which is already supplying considerable quantities to plants operated by the British Titan Products group in the United Kingdom, is to provided within the Union itself. British Titan Products, in association with African Explosives and Chemical Industries, Ltd., is to erect an ilmenite processing plant near Durban with a capacity of 10,000 tons a year as part of a worldwide programme of expansion. The South African plant is expected to be completed by 1962.

New Blast-Furnace.—The African Metals Corporation expects to complete the installation of and to commission its new blast-furnace towards the year-end, when the programme to expand supplies of raw materials from its own deposits will also be completed. Any surplus capacity resulting will be utilized to produce, mainly for export, pig-iron and/or ferro-manganese. A new washing plant has been installed at the corporation's phosphate quarries and this, *inter alia*, will contribute to a reduction in costs. An exploratory programme, especially for raw materials required in the corporation's activities, is being conducted.

Wire Ropes.—Developed in South Africa, an electronic testing device for detecting flaws in wire-ropes used by the mines for hoisting and hauling has been successfully applied by some of the major mining groups. The device has also been exported for trial and use overseas. The instrument utilizes electromagnetic flux

Prospecting.—An extensive survey of and search for beryllium deposits is being conducted by the Geological Survey of the Department of Mines, according to a recent report. The known deposits of the ores are located in Namaqualand, in the Pietersburg district, and in the vicinity of the Consolidated Murchison mine in the north-eastern Transvaal.

Sierra Leone Diamonds

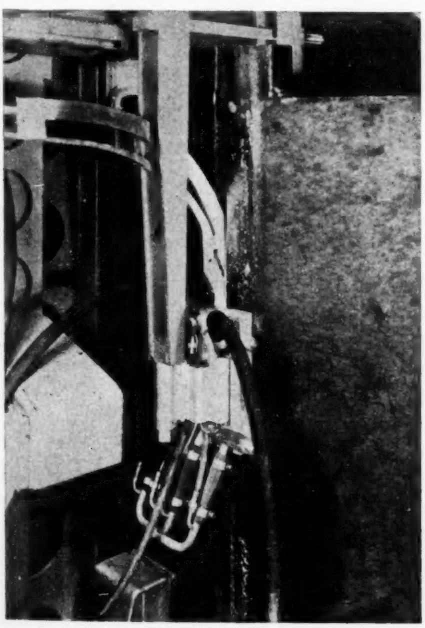
It was recently announced that the Executive Board of the Sierra Leone Government Diamond Office had met in London and reviewed the progress made in establishing the new marketing system. Certain changes to improve the procedure of purchasing diamonds at the Government Diamond Office were agreed. The Board noted that up to September 23 the total purchases for the month through the legitimate market amounted to £520,800, a vast improvement on any previous purchases at this time of the year.

Trade Notes

Brief descriptions of developments of interest to the mining engineer

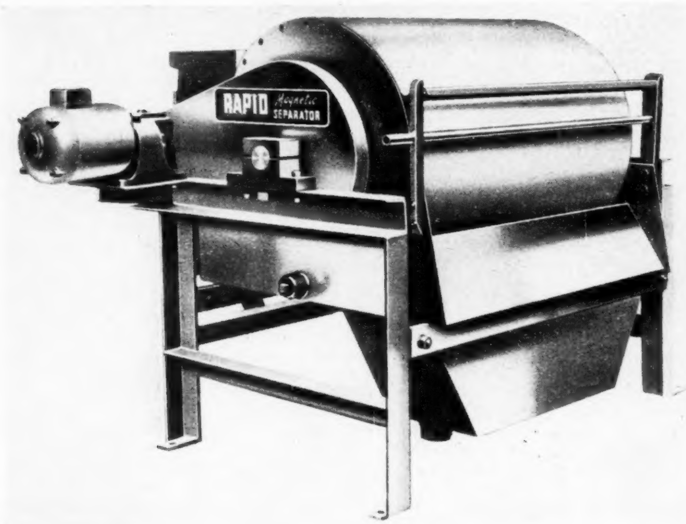
Welding Machine

At a recent demonstration of the various types of welding equipment manufactured by **Rockweld, Ltd.,** of Commerce Way, Croydon, Surrey, an entirely new automatic vertical unit was shown. Known as the "Vertomatic" and based on patents held by Vus (Bratislava), for whom Rockweld are the sole licensees in Great Britain, the equipment is considered to provide considerable economies in the welding of heavy plate. Plates to be butt-welded are arranged in a vertical position with a relatively small gap between the plate edges ($1\frac{1}{8}$ in. to $1\frac{1}{4}$ in.) into which the electrode wires are fed downwards through curved wire guides. Molten weld metal and slag are retained in the gap by water-cooled copper shoes which ride on the faces of the plates and traverse upwards automatically as welding proceeds, while the wire guides oscillate in the gap. This oscillation is important in securing the highly satisfactory weld metal properties obtained. Special compound wires contribute to the good mechanical properties in weld metal and allow special compositions of weld metal to be deposited. Deposition rates of 40 lb. to 50 lb. per hour are said to be possible with this machine, which is illustrated here.



Wet Drum Separator

In the heavy-media recovery flow-sheet the elimination of the densifier demands a magnetic concentrate of at least 2·2 sp. gr. when using magnetite, it is suggested in some notes issued by **Rapid Magnetic, Limited** (formerly known as Rapid Magnetic Machines, Ltd.), of Lombard Street, Birmingham. The desirability of treating the effluent from the wash screens directly without prethickening makes it imperative that maximum magnetite recovery be achieved even when treating very dilute slurries. The wet drum separator illustrated here incorporates

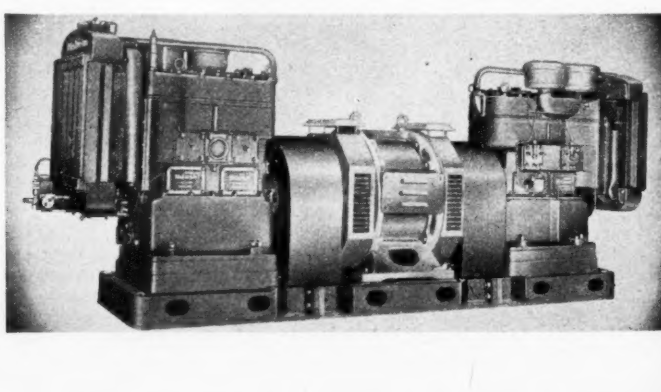


Rapid Wet Drum Separator.

a slimes overflow weir and adjustable orifice rings in the tailings outlet to eliminate the need for valves. Special attention has been paid to the header box which ensures proper presentation of the feed to the drum and eliminates overloading under severe surge conditions. The 30-in. diameter drum, provided with expendable stainless-steel outer covers, and available in widths up to 72 in., is energized by a powerful multipolar Alcomax permanent magnet unit, eliminating all wiring and accessories other than those necessary for the drive motor. Single-stage recovery at 80 Imperial gallons per minute per foot of magnet is exceptionally high under a very wide range of feed concentrations, a typical figure quoted from an actual installation being 99·6% recovery at 1·38% magnetite in feed (by weight). This represents a magnetite consumption of less than a tenth of a pound per ton of coal washed, based on an average of 150 gallons wash water per ton of coal. A clean magnetite concentrate of 2·4 sp. gr. is produced, independent of feed concentration.

Stationary Air-Compressors

Some particulars have been issued of a new duplex compressor unit which has been added to the range of machines manufactured by **Holman Bros., Ltd.,** of Camborne, Cornwall. The unit comprises a centrally-mounted



Holman Duplex Compressor Unit.

electric motor of either 156 b.h.p. or 230 b.h.p. fitted with a driving shaft extension at each end of which are coupled either two T.60 R or two T.36 R compressors, the drive being effected through either a flexible or a centrifugal coupling. The model illustrated here is that with T.60 R compressors and produces 1,050 c.f.m. at 100 p.s.i. and is suitable for operating at pressures up to 150 p.s.i. at a speed of 720 r.p.m. The other unit gives 610 c.f.m. at 100 p.s.i. from two T.36 R compressors at 1,000 r.p.m. This unit is also capable of operation up to 150 p.s.i. The compressors are of the two-stage reciprocating type, in which economy is achieved by the use of automatic control equipment limiting the actual running time to the period for which compressed air is required. Where a number of sets are in operation selection equipment can be provided to ensure an even loading cycle, thus preventing continuous maximum loading of any one unit.

An air blast aftercooler, where exceptionally cool dry air is required, is recommended for use with the unit and is particularly effective. In common with the compressor it does not require an external source of coolant and the motor can be electrically interlocked with that of the compressor. It is designed to deal with 525 cu. ft. of air per minute, at a maximum pressure of 150 p.s.i. and is compact and simple in design, employing a four-pass system for the air flow. The cooling elements are U tubes, constructed from highly finned copper or copper-alloy tubing expanded into a fixed tube plate, through which the cooling water passes. Included in the unit is an anti-surge tank which eliminates air surges and consequent vibration in the pipelines such as is often caused through intermittent delivery from reciprocating-type compressors. When working to full capacity the aftercooler requires 16 gallons to 18 gallons of water per minute.

Personal

R. G. BAKER has been elected President of the Institution of Mining Engineers for the year 1960–61 and will succeed Mr. T. A. ROGERS at the 66th annual general meeting of the Institution to be held in London on January 28, 1960.

G. W. T. BARNETT, of Shrewsbury, was incorrectly reported in the September issue as having been transferred from student membership of the Institution of Mining and Metallurgy to associate. Mr. Barnett was, in fact, formerly an Affiliate of the Institution.

C. W. BOISE has retired from the boards of Selection Trust, Consolidated African Selection Trust, and Seltrust Investments.

W. H. CARNAGHAN is home from Ghana.

J. V. CLEASBY has left for South Africa.

A. COATES is home from Northern Nigeria.

RICHARD W. FLAGG, who has served as assistant director of the Denver Ore Testing Division of the Denver Equipment Company for the past two years, has been promoted to chief metallurgist.

CHARLES FOX, partner in Daniel C. Griffith and Co., Assayers to the Bank of England, has retired from the firm after more than 52 years service.

M. I. FREEMAN has been appointed to the board of the Consolidated Zinc Corporation.

C. B. GEE has left for Northern Rhodesia.

ALASTAIR R. GRIFFITH, a great-grandson of the founder of Daniel C. Griffith and Co., has been appointed a director of the firm.

A. ROYDEN HARRISON has been appointed a director of Springs Mines, Ltd., and of Western Holdings, Ltd., in place of G. W. POOLEY, resigned.

J. H. HOLLY has been appointed deputy assistant general manager of Lake View and Star, Ltd.

P. H. KITTO was recently elected president of the Mine Ventilation Society of South Africa for 1959–60.

H. H. MCGREGOR, managing director of Production-Engineering (South Africa) (Pty.), Ltd., has been appointed chairman of Mining Services (P.E.), Ltd. At the same time J. P. MARTIN-BATES, a managing director of P.E. Holdings, Ltd., has joined the board, the other members of which are J. N. STEPHENS, managing director of P.E. Management Group (Australia) Pty., Ltd., G. KEITH ALLEN, and R. D. POWER.

D. M. MACPHERSON is home from Rhodesia.

E. A. MARTIN has been appointed London director of Padley and Venables, Ltd.

S. W. K. MORGAN has been appointed a director of Imperial Smelting Corporation.

D. MORRIS has left for Ceylon.

W. L. G. MUIR has left for Sierra Leone.

P. A. R. ODD is now in Northern Rhodesia.

H. D. OSBORNE is now in Malaya.

S. W. F. PATCHING, formerly head of the Mineral Dressing Group of the Atomic Energy Authority at Harwell, has joined the firm of Baker Perkins, Ltd., of Peterborough, as manager of a new mineral processing department.

E. A. WALKER has left for India.

W. S. WATKINSON is now in Nigeria.

PETER WESTERBERG is visiting Kenya.

D. M. WILLIAMS is now in Canada.

R. T. WILLIAMSON has left Canada for Northern Rhodesia.

JESSE WEST, who died on September 10, aged 65, was at the Royal School of Mines in 1914, but left to join the Forces. He served with distinction in France, being awarded the M.C. and bar. Returning to the School of Mines in 1919, after demobilization with the rank of Captain, he graduated in 1921 and left to take up work in Mexico. In 1925, however, Mr. West turned for a time to oil, but in the same year he decided to go to Nigeria, from 1931 until his retirement comparatively recently being connected with Ex-Lands Nigeria, Ltd. Mr. West, who

had also been awarded the O.B.E. and gained the Efficiency Decoration, was a Member of the Institution of Mining and Metallurgy.

WALTER HULL ALDRIDGE, one of the key men in the foundation and early success of the Consolidated Mining and Smelting Co. of Canada, Ltd., died in New York on August 16 at the age of 91. Mr. Aldridge, an engineer with an international reputation, was a Member of the Institution of Mining and Metallurgy as well as of its kindred institutions in Canada and the United States. In addition to the Egleston medal from Columbia University he was a W. L. Saunders medallist of the American Institute and in 1950 received the John Fritz medal for notable scientific or industrial achievement awarded by the American Society of Civil Engineers, the American Institute of Mining and Metallurgical Engineers, the American Society of Mechanical Engineers, and the American Institute of Electrical Engineers.

Metal Markets

During September [1]

Copper.—The main difference between September and earlier months of this year is that whereas formerly copper was mostly concerned with one strike—that in the American copper industry—it is now concerned with at least three. As far as the original copper strike is concerned it still continues and the prospects of an early settlement are no nearer than they were a month ago ; indeed they may be further off. Certainly matters in the steel strike seemed to have reached a grave impasse prior to intervention by the U.S. President at the end of September. In copper a symptom of a possibly equally rigid attitude by both parties was that Anaconda Co. rejected a union approach for a return to work on the basis of the old contract, the company declaring that it wished to negotiate for a new contract only.

Of the other strikes which the market has had to consider, the more important is the one that broke out at the El Teniente mine of the Braden Copper Co. in Chile on October 1 and will materially affect supplies to the U.K. and European markets. This strike was preceded by a good deal of " to-ing " and " fro-ing " in negotiations, which naturally had an unsettling effect on the market. However, an impression began to emerge that, in view of the high rate of production in Rhodesia and the fact that consumers in both the U.S.A. and Europe have not up to now shown any more eagerness to acquire additional supplies of copper, the loss of supplies from this direction might not be viewed too seriously by the market. In the event, however, prices exhibited marked strength once the strike actually began.

The third strike under consideration which also broke out on October 1 was a strike of longshoremen in New York. Up to the eleventh hour it seemed that this might be averted, but now that it has become an accomplished fact movement of copper into the U.S.A. to bolster consumers' dwindling stocks has now become impossible. During the month a certain amount of demand from the U.S.A. has reached London, but because of fears that copper afloat would be affected by the outbreak of such a dock strike this demand has not been on anything like the scale it would otherwise have been.

Circumstances are now much changed from a month ago, if only by virtue of the loss of metal through the U.S. strike being much more serious. Nevertheless, faced with this situation and with the prospect of a rising rate of industrial activity in the Western world over the remainder of this year, it should not be forgotten that the Metal Exchange has throughout taken an apparently excessively jaundiced view of copper for, however, the good reason that the market has kept firmly in mind that world copper supplies (featuring producers' stocks) have been consistently greater than demand.[1]

U.K. July copper consumption was 44,572 tons (32,034 tons refined), with production of primary refined 6,230 tons and of secondary refined 6,011 tons. Refined copper stocks eased to 69,049 tons, but those of blister rose to 12,937 tons.

Tin.—The feature of the tin market in September was the announcement that the International Tin Council had decided to raise the fourth quarter export quota to 30,000 tons, as compared with 25,000 tons in the current quarter. Although, as was intimated in the last report, an increase was anticipated, the margin of the advance took a good many people by surprise. Now that tin is so largely dominated by Tin Council and Buffer Stock activity dealers have had little to distract their attention from contemplation of this significant fact and a good many well-reasoned authoritative analyses of the significance of this move have been made. All concur that this advance should not in fact produce a state of over-supply of tin during this quarter and in fact that maintenance of such a quota during next year would not prejudice the position at any future date as far as can be seen. These calculations are very reasonably predicated on the assumption that tin-buying in the U.S.A. is being held back by the steel strike and that a surge of demand from that direction will be encountered in due course.[1]

U.K. July tin consumption was 1,682 tons, while production showed a sharp advance to 2,735 tons. Stocks were up to 11,255 tons.

Lead.—Lead has been depressed throughout September, only able to muster a slight appearance of strength in the context of a general improvement in the market,[1] which has mostly meant an improvement in copper, the tone of which often affects all the other metals. Unlike zinc, where some attempt has been made by the big producers firmly to limit the amount of material coming on to the market, lead is really in the same artificial position that was engendered by the U.S. Government applying stockpiling to political instead of strategic ends over five years ago. Also it is unhappily true that, whereas zinc can point to certain new and developing uses, lead is trying to make the best of a range of outlets that has not expanded in any material direction for a number of years. Lead for atomic radiation shielding is a good talking point but hardly a major tonnage outlet.

One of the U.S. lead strikes—that at U.S Smelting, Refining, and Mining's East Chicago plant—has now been ended and earlier reports of a strike at Bunker Hill have proved unfounded. The supply side is, therefore, still well ahead of

[1] Recent prices, pp. 152, 200.

[1] See Table, p. 200.

demand and it was noticeable that those countries that did not go in for accurately rationed shipping rates had almost all exhausted their U.S. third quarter import quotas either shortly or a long while before the period ended.

U.K. lead consumption in July was 26,851 tons and production of English refined 6,667 tons, a drop from June. Stocks jumped 10,000 tons to 67,586 tons.

Zinc.—Zinc has looked really healthy in September. Despite the U.S. steel strike, troubles in the U.K. motor industry itself, and in industries indirectly affecting it, demand has kept up in line with a good rate of consumption.[1] This is, of course, only in relation to a somewhat restricted rate of supplies, as it will be remembered that many important mines agreed earlier this year to hold down the level of their offerings of concentrates. The future position still has numerous problems; meanwhile the U.S. price has been advanced to 12 cents per lb., without waiting for the end of the steel strike, as many experts predicted would happen.

U.K. July consumption was 26,318 tons and production 5,507 tons. Stocks were slightly lower at 37,427 tons.

Iron and Steel.—Now that the holidays are over the true pattern of steel demand is becoming clearer. The general recession in the industry is past and the flow of orders for almost all types of steel products is mounting. The biggest pressure is for sheets (which, of course, did not suffer in the recession), for tinplate, and other light products—such as, strip, small bars, wire rods, and light sections. In fact it is largely the consumer industries which are setting the pace of recovery. The call for heavy steel is on a lower plane as capital investment has a good deal of ground to make up. However, interest in heavy sections is improving bit by bit and even plates are enjoying slightly better conditions, although the main demand is coming from the makers of large-diameter welded pipes and not from the shipyards.

It seems likely that steel production this year will reach about 19,750,000 tons and if the recovery is maintained then it might well attain 22,000,000 tons or more in 1960.

During the recession a higher ratio of scrap to pig-iron was used in the steel-melting shops, but now that ingot production is rising it is more economic to step up the use of pig-iron and idle blast-furnaces are being brought back into service.

With effect from September 28 certain changes were made to prices and extras of some products for the home market but the general range of quotations was not affected. Handmill tinplate and blackplate, production of which is now negligible and is confined to special grades, has been freed from maximum price control.

Iron Ore.—Iron ore imports are being increased as the need for a higher pig-iron production becomes necessary, but the aggregate for the first eight months of this year is still below the figure for the corresponding period of 1958—7,970,695 tons against 9,142,699 tons.

Aluminium.—September has seen the ending of the Russian undertaking given this time last year to limit exports to this country to 15,000 tons in 12 months. Then the Board of Trade was considering, but rejected, an appeal for an anti-dumping duty. The trend of arrivals of Russian aluminium during the first half of 1959, however, has reduced any anxiety about the possibility of a sudden influx of metal from this direction to negligible proportions. In fact, although official figures are some way behind events, it can be confidently asserted that U.K. aluminium imports from Russia in the October, 1958–September, 1959, period will not exceed 10,000 tons by any serious margin. Indeed, since the term of the Russian undertaking ended, offerings from that direction have, if anything, shrunk and offering prices by merchants importing the material have improved by perhaps a pound or two per ton.

Meanwhile Canadian (and perhaps one should add nowadays American) aluminium is still offered at £180 per ton delivered. Recently the idea that this price might be advanced in the near future has been gaining currency, but since it was only in the past month that the Canadian company felt able to advance its operating rate from 65% to 70% of capacity this must be viewed with caution.

Antimony.—The somewhat unexciting course of the United Kingdom market in imported Chinese and Russian antimony metal has been maintained recently. Low demand and steady prices are still apparent and there seems to be little likelihood of the picture changing in the immediate future. Imports of antimony in the first seven months of the year according to figures released mid-month amounted to 5,370 tons as compared with 5,835 tons in the same period last year. One reason for the diminished imports, of course, is the duty of £40 a ton levied on material of foreign origin. Another is the advantage of quicker delivery which English producers are able to offer.

Prices of open-market imported metal have remained stable for some time now as has that of English regulus for that matter. As in recent months it is priced at £197 10s. a ton, delivered.

Arsenic.—Arsenic continues to be a quiet stable-priced metal. Its present price of £400 a ton has held for quite some months now.

Bismuth.—The bismuth market continued on its usual uneventful course throughout September. The metal is at present quoted at a nominal 16s. a lb. for ton lots.

Cobalt.—September was another quiet month for trading in cobalt, it again being quoted at 14s. a lb. U.K. open-market price. The contract price, mentioned last month as being something of an innovation, remains at 12s. 6d. a lb.

Cadmium.—The price of cadmium has again remained unchanged at 9s. a lb. for U.K. and Empire material. Like the half-year statistics figures released last month, showing consumption of cadmium in the United Kingdom in the first seven months of this year, indicate that it remains ahead of that for the corresponding period of 1958. Consumption in the first seven months of this year amounted to 710 tons as against 599 tons a year ago.

Chromium.—Chromium metal is still fetching from 6s. 11d. to 7s. 4d. a lb., as it has done for some months past.

Tantalum.—The price of tantalum ore, which improved in July to 650s. to 700s. a unit, has remained stable ever since owing mainly to occasional European demand.

Platinum.—A firmer trend in the market for imported platinum in the United Kingdom developed in the second half of September and the quoted range has narrowed by 5s. to £26 15s. to £26 10s.

[1] See Table, p. 200.

per troy oz. U.K. and Empire refined metal is still quoted at £28 10s.

Iridium.—Iridium has been very quiet so far as market prices are concerned for some little time past. September was another quiet month and very little business was done in the metal at all. It is still being quoted at a nominal price of £24 to £26 10s. per troy oz.

Palladium.—Palladium has been in little demand in the last month and its price of £7 5s. per troy oz. is unaltered.

Osmium.—There has been little or no trading recently in osmium and the price is still nominally £23 to £32 10s. per troy oz.

Tellurium.—Tellurium lump and powder is still priced at 18s. a lb. Tellurium sticks are quoted at 20s.

Tungsten.—Early in the month the tungsten ore market showed a dramatic burst of activity, with heavy dealings in Europe and Japan. Prices rose steeply from the 102s. 6d. to 107s. 6d. quoted at the end of August, notching 162s. 6d. to 167s. 6d. by the middle of the second week of the month. Shortage of supplies was probably the main factor accounting for this, despite the interest shown by consumers.

As it happened merchants tended to push the price up themselves as they bid against one another in order to stock up for the bigger demands they felt were bound to come. Interest tended to tail off as the month progressed, however, and since it reached the figure mentioned above the price has gone slowly but progressively downwards again until it is now as low as 132s. 6d. to 137s. 6d.

Also last month the Board of Trade announced that its agent, British Tungsten, Ltd., was to resume selling tungsten ore after an interval of two years. Coming as it did when the price was at its peak it could hardly have failed to ensure that future trends would be downwards, as they eventually turned out to be.

Nickel.—There have been no features of a market nature to nickel in the past month. Nowadays, of course, everybody can buy all the nickel they want at £600 per ton delivered. If the U.S. Government succeeds in selling its Nicaro smelter, which it is again trying to do, there will presumably be that much more excess supply on the market.

Chrome Ore.—Chrome ore is still very quiet, as it is not now so easy to enter into new barter deals for the ore. There are also no new ferro-chrome barters at present, although a good volume of ore is still being taken up working off old ferro-chrome barter contracts. The prices are unchanged, Rhodesian metallurgical being still £15 15s. per ton c.i.f.

Molybdenite.—There is nothing new to say about molybdenite. Like nickel, another virtually monopoly production, it is in plentiful supply but the price is unaltered at 8s. 11d. per lb. Mo contained f.o.b. mine.

Manganese Ore.—A certain amount of activity has been seen in manganese in the past month, but unfortunately almost all of it has either been on barter which is unrealistic, or speculative, which is better than nothing, but no substitute for real consumer interest. When the latter will emerge is still uncertain. It certainly does not follow that, because there is now a steel strike in the U.S.A. and no manganese demand, when there is no strike there will be manganese demand from that direction.

Tin, Copper, Lead, and Zinc Markets

Tin, minimum, 99·75%; Copper, electro; Lead, minimum 99·75%; and Zinc, minimum 98%, per ton.

Date	Tin		Copper		Lead		Zinc	
	Settlement	3 Months	Spot	3 Months	Spot	3 Months	Spot	3 Months
	£ s.	£ s.	£ s.	£ s.	£ s.	£ s.	£ s.	£ s.
Sept. 10	793 10	792 5	232 5	232 2½	71 10	72 16¼	86 8¾	85 3¾
11	793 10	793 0	232 7½	232 7½	70 16¼	72 3¾	86 10	85 3¾
14	793 10	793 0	229 10	230 12½	70 10	72 1¼	86 6¼	85 3¾
15	793 10	793 15	226 12½	227 15	70 17½	72 7½	85 7½	85 2½
16	793 10	793 5	225 7½	226 12½	70 12½	71 17½	85 17½	84 17½
17	793 10	794 0	226 17½	228 5	71 0	72 3¾	86 2½	85 2½
18	793 10	793 15	225 7½	227 0	70 18¾	72 1¼	86 1¼	85 3¾
21	793 0	792 0	224 7½	225 2½	69 7½	70 17½	84 12½	83 17½
22	792 0	790 15	224 7½	225 7½	69 13¾	70 18¾	85 12½	84 18¾
23	791 10	790 15	225 12½	226 5	69 10	70 18¾	85 2½	84 7½
24	793 10	790 15	227 2½	227 17½	69 16¼	71 2½	85 7½	84 7½
25	793 10	792 5	229 2½	229 17½	69 16¼	71 3¾	85 12½	84 16¼
28	793 10	792 5	228 2½	228 12½	69 13¾	71 3¾	85 17½	85 2½
29	792 10	791 5	227 2½	227 17½	69 1¼	70 13¾	85 13¾	84 17½
30	794 0	793 5	227 2½	228 2½	69 11¼	70 18¾	87 10	85 12½
Oct. 1	794 0	794 5	228 12½	229 12½	70 2½	71 6¼	86 7½	85 2½
2	794 10	794 15	234 17½	234 2½	70 6¼	71 7½	86 17½	85 8¾
5	794 10	794 15	235 12½	235 5	70 3¾	71 5	87 2½	85 7½
6	794 10	793 5	233 17½	233 12½	70 1¼	71 1¼	86 15	86 2½
7	794 10	794 15	233 17½	233 7½	70 1¼	71 3¾	87 2½	85 7½
8	794 10	794 15	232 7½	232 7½	70 12½	71 13¾	87 3¾	85 8¾
9	—	—	—	—	—	—	—	—

Statistics

TRANSVAAL AND O.F.S. GOLD OUTPUTS

	Aug.		Sept.	
	Treated Tons	Yield Oz.*	Treated Tons	Yield Oz.†
Blyvooruitzicht	131,000	84,495	127,000	84,456
Brakpan	14[illegible],000	17,180	138,000	17,027
Buffelsfontein‡	144,000	54,755	144,000	54,754
City Deep	120,000	24,642	114,000	23,488
Cons. Main Reef	104,000	18,630	90,000	17,842
Crown Mines	224,000	35,234	221,000	35,185
Daggafontein	244,000	48,479	244,000	48,265
Doornfontein‡	95,000	38,580	95,000	38,565
D'rb'n Roodeport Deep	200,000	36,556	194,000	35,660
East Champ D'Or‡	12,000	340	12,000	369
East Daggafontein	103,000	17,436	104,000	17,628
East Geduld	143,000	42,186	143,000	42,186
East Rand P.M.	227,000	59,722	210,000	56,230
Eastern Transvaal Consol	18,800	6,126	19,000	6,339
Ellaton‡	31,500	7,241	30,500	6,996
Freddies Consol.	60,000	14,486	61,000	14,587
Free State Geduld	91,000	74,288	93,000	76,392
Geduld	75,000	14,364	75,000	14,367
Government G.M. Areas‡	53,000	10,622	52,000	10,706
Grootvlei Proprietary	225,000	47,269	225,000	47,026
Harmony Gold Mining	140,000	54,964	138,000	54,863
Hartebeestfontein‡	91,000	48,685	91,000	48,230
Libanon	110,000	25,709	110,000	25,734
Loraine	82,000	16,031	82,000	16,194
Luipaards Vlei‡	125,000	14,319	125,000	14,544
Marievale Consolidated	98,000	23,706	97,000	23,436
Merriespruit‡	—	—	—	—
Modderfontein East	139,000	13,663	137,000	13,281
New Kleinfontein	83,000	10,786	81,000	10,814
New Klerksdorp‡	10,100	1,111	10,800	1,258
President Brand	120,000	98,166	120,000	98,406
President Steyn	104,000	41,221	104,000	41,310
Rand Leases	196,000	28,910	191,000	28,366
Randfontein‡	208,000	15,320	208,000	14,494
Rietfontein Consolid't'd.	16,000	4,308	16,000	4,302
Robinson Deep	53,000	11,077	56,000	11,107
Rose Deep	31,000	5,111	34,000	5,652
St. Helena Gold Mines	160,000	50,002	160,000	50,403
Simmer and Jack	83,000	16,376	82,000	16,528
S. African Land and Ex.	100,000	20,755	98,000	20,433
S. Roodepoort M.R.	29,000	7,072	30,000	7,088
Spaarwater Gold	11,000	3,423	11,000	3,421
Springs	104,000	14,333	105,000	14,384
Stilfontein Gold Mining‡	150,000	69,934	159,000	71,600
Sub Nigel	66,500	15,824	66,500	15,744
Transvaal G.M. Estates	7,200	1,853	6,700	1,866
Vaal Reefs‡	95,900	42,750	100,000	45,000
Van Dyk Consolidated	73,000	14,014	73,000	14,004
Venterspost Gold	128,000	32,154	126,000	31,721
Village Main Reef	28,500	4,731	30,000	4,769
Virginia O.F.S.‡	134,000	30,987	132,000	30,360
Vlakfontein	52,000	18,564	52,000	18,617
Vogelstruisbult‡	90,000	20,053	88,000	19,932
Welkom Gold Mining	100,000	31,170	100,000	31,261
West Driefontein‡	99,000	90,688	102,000	93,391
West Rand Consol.‡	222,000	22,725	215,000	21,942
Western Holdings	136,000	84,320	137,000	85,627
Western Reefs	139,000	36,765	141,500	37,498
Winkelhaak	80,000	21,009	80,000	21,809
Witwatersrand Nigel	18,200	4,376	18,400	4,383

† 250s. 0d. * 249s. 2d. ‡ Gold and Uranium.

COST AND PROFIT IN THE UNION

	Tons milled	Yield per ton	Work'g cost per ton	Work'g profit per ton	Total working profit
		s. d.	s. d.	s. d.	£
June, 1958*	16,435,500	64 9	46 6	18 3	24,358,945
July	—	—	—	—	—
August	—	—	—	—	—
Sept.*	16,760,400	65 10	46 9	19 1	25,633,898
Oct.	—	—	—	—	—
Nov.	—	—	—	—	—
Dec.	16,540,150	67 7	47 10	19 9	25,934,441
Jan., 1959	—	—	—	—	—
Feb.	—	—	—	—	—
Mar.	16,743,500	68 0	45 4	22 8	25,934,881
April	—	—	—	—	—
May	—	—	—	—	—
June	17,845,100	69 1	45 2	23 11	28,473,191

* 3 Months.

PRODUCTION OF GOLD IN SOUTH AFRICA

	Rand and O.F.S.	Outside	Total
	Oz.	Oz.	Oz.
September, 1958	1,465,697	36,799	1,502,496
October	1,516,701	44,025	1,560,726
November	1,484,844	32,349	1,517,193
December	1,480,525	40,372	1,520,895
January, 1959	1,506,670	39,515	1,546,187
February	1,472,090	34,618	1,506,708
March	1,561,196	32,271	1,593,467
April	1,616,891	36,815	1,653,706
May	1,641,990	30,371	1,672,361
June	1,665,503	34,465	1,699,968
July	1,700,968	48,414	1,749,382
August	1,699,098	36,052	1,735,150

NATIVES EMPLOYED IN THE SOUTH AFRICAN MINES

	Gold Mines	Coal Mines	Total
December 31, 1958	329,234	32,946	362,180
January 31, 1959	350,656	—	—
February 28	396,217	33,859	430,076
March 31	379,257	32,982	412,239
April 30	383,710	33,081	416,791
May 31	385,278	33,186	418,464
June 30	383,903	33,146	417,049
July 31	381,190	33,295	414,485
August 31	377,257	32,994	410,251

MISCELLANEOUS METAL OUTPUTS

	4-Week Period To Sept. 19		
	Tons Ore	Lead Concs. tons	Zinc Concs. tons
Broken Hill South	22,250	3,649	4,422
Electrolytic Zinc	—	—	—
Lake George	18,007	1,198	2,351
Mount Isa Mines**	53,080	3,650†	2,142
New Broken Hill	35,780	4,503	7,952
North Broken Hill	31,926	6,038	6,407
Zinc Corp.	49,550	7,544	7,878
Rhodesia Broken Hill*	—	3,600†	7,300†

* 3 Mths. ** Copper 3,070 tons. † Metal.

RHODESIAN GOLD OUTPUTS

	August		Sept.	
	Tons	Oz.	Tons	Oz.
Cam and Motor	32,096	—	—	—
Falcon Mines	20,400	3,886	20,350	3,855
Globe and Phœnix	6,000	3,067	5,600	2,912
Motapa Gold Mining	13,200	1,402	—	—
Mazoe	2,957	—	—	—
Coronation Syndicate	12,248	—	—	—
Phœnix Prince*	—	—	—	—

* 3 Months.

WEST AFRICAN GOLD OUTPUTS

	August		Sept.	
	Tons	Oz.	Tons	Oz.
Amalgamated Banket	53,260	15,048	60,108	14,703
Ariston Gold Mines	39,920	12,969	40,160	13,420
Ashanti Goldfields	34,000	27,000	34,000	27,900
Bibiani	33,500	7,200	33,500	7,200
Bremang	—	6,040	—	—
Ghana Main Reef	11,907	4,145	11,448	4,135
Konongo	6,730	3,785	6,500	3,780
Lyndhurst	—	—	—	—

PRODUCTION OF GOLD AND SILVER IN RHODESIA

	1958		1959	
	Gold (oz.)	Silver (oz.)	Gold (oz.)	Silver (oz.)
January	44,305	46,553	46,489	18,077
February	43,591	21,313	43,366	19,806
March	43,830	8,179	48,397	17,394
April	46,587	22,573	—	—
May	46,015	19,937	46,423	46,280
June	46,453	20,105	49,995	31,386
July	44,244	19,170	—	—
August	47,484	20,549	—	—
September	48,295	21,141	—	—
October	46,311	6,342	—	—
November	47,994	16,435	—	—
December	48,888	30,724	—	—

WESTRALIAN GOLD PRODUCTION

	1957	1958	1959
	Oz.	Oz.	Oz.
January	106,722	66,562	63,924
February	64,949	65,965	65,035
March	67,121	65,420	65,408
April	66,435	60,855	62,686
May	64,886	64,196	64,184
June	65,142	67,929	74,590
July	74,420	81,106	78,974
August	75,727	68,610	—
September	64,422	68,744	—
October	64,524	70,128	—
November	65,700	67,562	—
December	66,562	120,106	—
Total	846,610	867,187	—

AUSTRALIAN GOLD OUTPUTS

	4-Week Period			
	To Aug. 18		To Sept. 15	
	Tons	Oz.	Tons	Oz.
Central Norseman	14,225	7,978	14,051	7,228
Crœsus Proprietary	—	—	—	—
Gold Mines of Kalgoorlie	40,509	11,952	39,981	10,831
Golden Horse Shoe*	—	—	—	—
Gt. Boulder Gold Mines*	—	—	—	—
Gt. Western Consolidated	36,920	6,167	35,555	5,822
Hill 50*	13,798	6,552	13,943	—
Kalgurli Ore Treatment	—	—	—	—
Lake View and Star*	—	—	—	—
Moonlight Wiluna*	8,268	3,642	—	—
Morning Star (G.M.A.)	1,654	365	862	631
Mount Ida*	—	—	—	—
New Coolgardie	—	—	—	—
North Kalgurli	28,611	6,970	28,347	—
Sons of Gwalia	12,706	2,329	12,278	—
Mount Morgan	—	4,126	—	3,893

*3 Months

ONTARIO GOLD AND SILVER OUTPUT

	Tons Milled	Gold Oz.	Silver Oz.	Value Canad'n $
April, 1958	785,264	229,361	38,323	7,873,264
May	801,102	228,590	35,712	7,789,644
June	775,384	228,123	37,535	7,745,425
July	750,410	228,960	42,275	7,740,144
August	740,459	218,126	38,940	7,355,406
September	771,115	202,798	31,543	7,006,517
October	801,965	209,006	34,914	7,178,218
November	783,065	230,251	35,097	7,842,435
December	787,573	219,351	30,989	7,490,094
January, 1959	799,178	227,656	41,277	7,700,672
February	727,843	227,981	32,976	7,798,523
March	807,952	223,728	33,045	7,616,425
April	776,583	225,027	32,778	7,712,425
May	791,199	227,924	34,006	7,713,970
June	768,725	213,486	31,692	7,178,823
July	—	—	—	—

MISCELLANEOUS GOLD AND SILVER OUTPUTS

	Aug.		Sept.	
	Tons	Oz.	Tons	Oz.
British Guiana Cons.	—	—	—	—
Central Victoria Dredging	—	—	—	—
Clutha River	—	706	—	—
Emperor Mines (Fiji)*	—	—	—	—
Frontino Gold (Colombia)	—	—	—	—
Geita Gold (Tanganyika)	—	—	—	—
Harrietville (Aust.)	—	—	—	—
Lampa (Peru)†	—	37,011	—	—
Loloma (Fiji)*	—	—	—	—
New Guinea Goldfields	—	—	—	—
St. John d'el Rey (Brazil)	—	—	—	—
Yukon Consol.	—	$384,000	—	—

* 3 Months. † Oz. Silver : Copper, 82 tons : 85½ tons.

OUTPUTS OF MALAYAN TIN COMPANIES IN LONG TONS OF CONCENTRATES

	July	Aug.	Sept.
Ampat Tin	38	39	48½
Austral Amalgamated	—	—	—
Ayer Hitam	—	—	—
Batu Selangor	—	—	—
Berjuntai	127	130	144
Chenderiang	—	—	—
Gopeng Consolidated	—	—	—
Hongkong Tin	—	—	—
Idris Hydraulic	—	—	—
Ipoh	—	—	—
Jelapang Tin	—	—	—
Kampong Lanjut	83	43	45½
Kamunting	100	109	107½
Kent (F.M.S.)	—	—	—
Kepong	—	—	—
Killinghall	—	—	—
Kinta Kellas	—	—	—
Kinta Tin Mines	—	—	—
Klang River	—	—	—
Kramat	7	66	53
Kuala Kampar	80	81	19½
Kuala Lumpur	—	—	—
Kuchai	—	—	—
Lahat Mines	—	—	—
Larut	—	—	—
Lower Perak	69	24½	30
Malayan	—	—	—
Malaysiam	6	8	—
Pacific Tin Consolidated	—	—	—
Pahang Consolidated	—	—	404*
Pengkalen	—	—	—
Petaling Tin	—	—	—
Puket	—	—	—
Rahman Hydraulic	—	—	—
Rambutan	—	—	—
Rantau	39½	40	39
Rawang Concessions	—	—	—
Rawang Tin Fields	—	—	—
Renong	—	—	178*
Selayang	—	—	—
Siamese Tin Syndicate (Malaya)	—	42	14
Southern Kinta	135	164½	149½
Southern Malayan	—	—	—
Southern Tronoh	—	—	—
Sungei Besi	—	—	—
Sungei Kinta	—	—	—
Sungei Way	—	—	—
Taiping Consolidated	18	14	15½
Tambah	—	—	—
Tanjong	—	—	—
Tekka	—	—	—
Tekka-Taiping	—	—	—
Temoh	—	—	—
Tongkah Compound	—	—	—
Tongkah Harbour	22	33	31½
Tronoh	—	—	—
Ulu Klang	—	—	—

* 3 Months.

MISCELLANEOUS TIN COMPANIES' OUTPUTS IN LONG TONS OF CONCENTRATES

	Aug.		Sept.	
	Tin	Columbite	Tin	Columbite
Amalgamated Tin Mines ..	226	37	253	—
Anglo-Burma Tin *	32	—	—	—
Bangrin	52	—	23	—
Beralt	30	166†	21	172†
Bisichi	39	34	—	—
Ex-Lands Nigeria	51	—	41	—
Geevor	32	—	54	—
Gold and Base Metal	56	8	—	—
Jantar Nigeria	8½	20½	13	17
Jos Tin	10	—	—	—
Kaduna Prospectors	4	—	4	—
Kaduna Syndicate	20	—	16	—
Katu Tin	26	—	30	—
Keffi Tin	—	—	—	—
London Nigerian Mines ...	—	—	—	—
Mawchi Mines	—	—	—	—
Naraguta Extended	8	—	—	—
Naraguta Karama	6½	—	—	—
Naraguta Tin	—	—	—	—
Renong Consolidated	—	—	—	—
Ribon Valley (Nigeria)	12½	2½	—	—
Siamese Tin Syndicate	74	—	63	—
South Bukeru	—	—	—	—
South Crofty	48	—	81	—
Tavoy Tin	—	—	—	—
Tin Fields of Nigeria	—	—	—	—
United Tin Areas of Nigeria	—	—	—	—

* 3 months. † Wolfram.

SOUTH AFRICAN MINERAL OUTPUT

June, 1959

Gold	1,703,050 oz.
Silver	169,069 oz.
Diamonds	226,280 carats.*
Coal	3,373,642 tons.
Copper	(a) — tons in matte and copper-gold concentrates. (b) 4,805 tons of 99·19%.
Tin	197 tons concs.
Platinum (concentrates, etc.)	—
Platinum (crude)	—
Asbestos	15,778 tons.
Chrome Ore	52,957 tons.
Manganese Ore	88,833 tons.
Lead Concs.	— tons.

* May., 1959.

IMPORTS OF ORES, METALS, ETC., INTO UNITED KINGDOM

		July	Aug.
Iron Ore	tons	1,294,717	1,206,089
Manganese Ore	,,	18,946	45,385
Iron and Steel	,,	57,469	46,857
Iron Pyrites	,,	10,654	21,464
Copper Metal	,,	32,953	35,921
Tin Ore	,,	7,648	—
Tin Metal	,,	—	4,955
Lead	,,	26,000	9,363
Zinc Ore and Conc.	,,	13,846	12,762
Zinc	,,	12,765	12,594
Tungsten Ores	,,	372	340
Chrome Ore	,,	18,263	22,540
Bauxite	,,	31,900	6,902
Antimony Ore and Concs.	,,	—	1,140
Titanium Ore	,,	25,633	16,732
Nickel Ore	,,	—	—
Tantalite/Columbite	,,	33	20
Sulphur	,,	34,498	30,580
Barytes	,,	2,227	2,151
Asbestos	,,	13,904	11,719
Magnesite	,,	1,350	749
Mica	,,	667	575
Graphite	,,	128	326
Mineral Phosphates	,,	100,626	81,479
Molybdenum Ore	,,	183	480
Nickel	cwt.	87,112	123,314
Aluminium	,,	301,368	485,111
Mercury	lb.	223,442	112,122
Bismuth	,,	173,432	48,213
Cadmium	,,	286,186	184,538
Cobalt and Cobalt Alloys	,,	136,102	402,253
Selenium	,,	181,111	19,648
Petroleum Motor Spirit 1,000	gals.	88,447	96,609
Crude	,,	861,902	999,862

Prices of Chemicals

The figures given below represent the latest available.

		£	s.	d.
Acetic Acid, Glacial	per ton	106	0	0
,, ,, 80% Technical	,,	97	0	0
Alum, Comml.	,,	25	0	0
Aluminium Sulphate	,,	16	10	0
Ammonia, Anhydrous	per lb.		2	0
Ammonium Carbonate	per ton	59	0	0
,, Chloride, 98%	,,	26	0	0
,, Phosphate (Mono- and Di-) ...	,,	102	0	0
Antimony Sulphide, golden	per lb.		3	0
Arsenic, White, 99/100%	per ton	47	10	0
Barium Carbonate (native), 94%	,,	Nominal		
,, Chloride	,,	53	0	0
Barytes (Bleached)	,,	20	0	0
Benzene	per gal.		5	2
Bleaching Powder, 36% Cl.	per ton	30	7	6
Borax	,,	46	0	0
Boric Acid, Comml.	,,	77	0	0
Calcium Carbide	,,	40	17	9
,, Chloride, solid, 70/75%	,,	13	5	0
Carbolic Acid, crystals	per lb.		1	6
Carbon Bisulphide	per ton	62	10	0
Chromic Acid (ton lots)	per lb.		2	2¾
Citric Acid	per cwt.	11	0	0
Copper Sulphate	per ton	74	10	0
Creosote Oil (f.o.r. in Bulk)	per gal.		1	2
Cresylic Acid, refined	,,		6	10
Hydrochloric Acid 28° Tw.	per carboy		13	0
Hydrofluoric Acid, 59/60%	per lb.		1	1
Iron Sulphate	per ton	3	17	6
Lead, Carbonate, white	,,	116	15	0
,, Nitrate	,,	116	0	0
,, Oxide, Litharge	,,	106	15	0
,, Red	,,	104	15	0
Lime Acetate, brown	,,	40	0	0
Lithopone	,,	56	10	0
Magnesite, Calcined	,,	20	0	0
,, Raw	,,	9	0	0
Magnesium Chloride, ex Wharf	,,	16	0	0
,, Sulphate, Comml.	,,	15	10	0
Methylated Spirit, Industrial, 66 O.P.	per gal.		6	3
Nitric Acid, 80° Tw.	per ton	37	10	0
Oxalic Acid	,,	129	0	0
Phosphoric Acid (S.G. 1·750)	per lb.		1	4
Pine Oil	per ton	Nominal		
Potassium Bichromate	per lb.		1	2¼
,, Carbonate (hydrated)	per ton	72	10	0
,, Chloride	,,	21	0	0
,, Iodide	per lb.		6	10
,, Amyl Xanthate	,,	Nominal		
,, Ethyl Xanthate	,,	Nominal		
,, Hydrate (Caustic) flake	per ton	118	0	0
,, Nitrate	per cwt.	4	1	0
,, Permanganate	per ton	193	10	0
,, Sulphate, 50%	,,	20	5	0
Sodium Acetate	,,	75	10	0
,, Arsenate, 58–60%	,,	Nominal		
,, Bicarbonate	,,	15	0	0
,, Bichromate	per lb.		1	0
,, Carbonate (crystals)	per ton	Nominal		
,, ,, (Soda Ash) 58%	,,	13	15	0
,, Chlorate	,,	91	0	0
,, Cyanide 100% NcAN basis	per cwt.	6	6	6
,, Hydrate, 76/77%, solid	per ton	33	0	0
,, Hyposulphite, Comml.	,,	32	15	0
,, Nitrate, Comml.	,,	29	0	0
,, Phosphate (Dibasic)	,,	40	10	0
,, Prussiate	per lb.		1	0¼
,, Silicate	per ton	11	10	0
,, Sulphate (Glauber's Salt)	,,	9	15	0
,, ,, (Salt-Cake)	,,	10	0	0
,, Sulphide, flakes, 60/62%	,,	38	12	6
,, Sulphite, Comml.	,,	27	15	0
Sulphur, American, Rock (Truckload)	,,	14	0	0
,, Ground, Crude	,,	17	10	0
Sulphuric Acid, 168° Tw.	,,	12	0	0
,, ,, free from Arsenic, 140° Tw.	,,	7	0	0
Superphosphate of Lime, 18% P_2O_5	,,	14	18	6
Tin Oxide	,,	Nominal		
Titanium Oxide, Rutile	,,	172	0	0
,, White, 25%	,,	85	0	0
Zinc Chloride	,,	95	0	0
,, Dust, 95/97% (4-ton lots)	,,	114	0	0
,, Oxide	,,	101	0	0
,, Sulphate	,,	32	0	0

Share Quotations

Shares of £1 par value except where otherwise stated.

GOLD AND SILVER:

SOUTH AFRICA:	Sept. 8, 1959 £	s.	d.	Oct. 8, 1959 £	s.	d.
Blinkpoort (5s.)	4	12	6	4	11	3
Blyvooruitzicht (2s. 6d.)	1	8	3	1	9	3
Brakpan (5s.)		5	0		5	9
Buffelsfontein (10s.)	2	8	3	2	9	0
City Deep	1	1	9	1	1	6
Consolidated Main Reef	1	1	0	1	1	6
Crown Mines (10s.)	1	8	3	1	8	0
Daggafontein (5s.)	1	7	6	1	7	9
Dominion Reefs (5s.)		13	0		13	0
Doornfontein (10s.)	1	12	0	1	13	9
Durban Roodepoort Deep (10s.)	1	14	3	1	14	6
East Champ d'Or (2s. 6d.)		2	3		2	0
East Daggafontein (10s.)		9	3		8	9
East Geduld (4s.)	1	4	0	1	6	9
East Rand Ext. (5s.)	1	8	6	1	7	3
East Rand Proprietary (10s.)	2	3	3	2	3	6
Freddies Consol.		2	9		2	6
Free State Dev. (5s.)		11	0		9	9
Free State Geduld (5s.)	9	5	9	8	18	9
Free State Saaiplaas (10s.)	1	2	3	1	1	3
Geduld	3	5	0	3	11	3
Government Gold Mining Areas (3d.)		3	9		3	3
Grootvlei (5s.)	1	0	9	1	2	6
Harmony (5s.)	2	1	6	1	18	3
Hartebeestfontein (10s.)	2	19	0	3	2	3
Libanon (10s.)		12	0		15	0
Loraine (10s.)	1	14	6	1	13	9
Luipaards Vlei (2s.)		8	3		8	0
Marievale (10s.)	1	7	9	1	7	0
Merriespruit (5s.)		5	3		4	6
Modderfontein B (3d.)		2	6		2	6
Modderfontein East		17	3		17	0
New Kleinfontein		5	3		5	3
New Pioneer (5s.)	1	18	0	1	18	0
New State Areas (15s. 6d.)		1	9		1	6
President Brand (5s.)	3	12	3	3	19	3
President Steyn (5s.)	1	12	3	1	11	0
Rand Leases (9s. 3d.)		6	9		7	6
Randfontein	1	2	6	1	2	3
Rietfontein (3d.)		5	0		5	0
Robinson Deep (5s. 6d.)		6	9		7	0
Rose Deep (3s. 6d.)		10	0		10	0
St. Helena (10s.)	4	3	3	4	1	6
Simmer and Jack (1s. 6d.)		2	0		2	3
South African Land (3s. 6d.)	1	0	9	1	1	6
Springs (5d.)		1	9		2	3
Stilfontein (5s.)	2	1	9	1	19	6
Sub Nigel (3d.)		12	2		11	9
Vaal Reefs (5s.)	2	1	9	2	3	6
Van Dyk (3s.)		3	9		3	9
Venterspost (10s.)		16	6		16	3
Virginia (5s.)		6	3		5	3
Vlakfontein (10s.)		18	9		18	6
Vogelstruisbult (3d.)		7	9		7	3
Welkom (5s.)	1	1	6	1	2	9
West Driefontein (10s.)	8	0	0	7	18	0
West Rand Consolidated (10s.)	1	2	0	1	2	3
West Witwatersrand Areas (2s. 6d.)	3	11	6	3	12	9
Western Holdings (5s.)	8	8	0	8	8	6
Western Reefs (5s.)	1	6	0	1	5	3
Winkelhaak (10s.)	1	5	6	1	7	0
Witwatersrand Nigel (2s. 6d.)		1	3		1	3
Zandpan (10s.)		18	9		18	9
RHODESIA:						
Cam and Motor (2s. 6d.)		9	6		9	3
Chicago-Gaika (10s.)		17	6		17	6
Coronation (2s. 6d.)		5	0		4	9
Falcon (5s.)		9	9		9	6
Globe and Phœnix (5s.)	1	11	3	1	11	6
Motapa (5s.)			9			9
GOLD COAST:						
Amalgamated Banket (3s.)		1	4½		1	3
Ariston Gold (2s. 6d.)		5	0		4	9
Ashanti Goldfields (4s.)	1	1	6	1	4	0
Bibiani (4s.)		3	9		4	6
Bremang Gold Dredging (5s.)		2	6		2	6
Ghana Main Reef (5s.)		3	3		3	0
Konongo (2s.)		2	0		1	9
Kwahu (2s.)		5	0		5	3
Western Selection (5s.)		5	9		6	0
AUSTRALASIA:						
Gold Fields Aust. Dev. (3s.), W.A.		2	6		2	6
Gold Mines of Kalgoorlie (10s.)		9	3		9	6
Great Boulder Propriet'y (2s.), W.A.		12	9		12	6
Lake View and Star (4s.), W.A.	1	7	0	1	7	0
London-Australian (2s.)			9		—	
Mount Morgan (10s.), Q.		17	6		16	9
New Guinea Gold (4s. 3d.)		1	9		1	6
North Kalgurli (1912) (2s.), W.A.		11	3		11	3
Sons of Gwalia (10s.), W.A.		3	0		2	9
Western Mining (5s.), W.A.		10	9		10	6

MISCELLANEOUS:	Sept. 8, 1959 £	s.	d.	Oct. 8, 1959 £	s.	d.
Fresnillo ($1·00)	1	11	6	1	9	6
Kentan Gold Areas	1	18	3	1	18	9
St. John d'el Rey, Brazil	3	6	9	2	17	6
Yukon Consolidated ($1)		5	9		5	6

COPPER:

	£	s.	d.	£	s.	d.
Bancroft Mines (5s.), N. Rhodesia	1	3	9	1	3	3
Esperanza (2s. 6d.), Cyprus		1	9		1	9
Indian (2s.)		4	9		4	9
MTD (Mangula) (5s.)		9	6		9	0
Messina (5s.), Transvaal	5	10	0	5	7	3
Mount Lyell, Tasmania	1	5	6	1	9	0
Nchanga Consolidated, N. Rhodesia	12	15	0	3	3	0
Rhokana Corporation, N. Rhodesia	31	0	0	30	15	0
Roan Antelope (5s.), N. Rhodesia		8	0		8	0
Tanganyika Concessions (10s.)	2	5	9	2	7	6

LEAD-ZINC:

	£	s.	d.	£	s.	d.
Broken Hill South (1s.), N.S.W.		11	3		11	0
Burma Mines (3s. 6d.)		2	0		2	0
Consol. Zinc Corp. Ord.	3	3	0	3	3	9
Lake George (5s.), N.S.W.		4	0		3	6
Mount Isa, Queensland (5s. Aust.)	2	3	9	2	9	3
New Broken Hill (5s.), N.S.W.	1	13	3	1	13	0
North Broken Hill (5s.), N.S.W.	4	1	3	4	6	0
Rhodesia Broken Hill (5s.)		10	0		10	0
San Francisco (10s.), Mexico		19	9		19	6

TIN:

	£	s.	d.	£	s.	d.
Amalgamated Tin (5s.), Nigeria		9	9		9	0
Ampat (4s.), Malaya		10	6		10	9
Ayer Hitam (5s.), Malaya	1	19	0	1	18	6
Beralt (5s.), Portugal	1	13	3	1	11	6
Bisichi (2s. 6d.), Nigeria		4	3		4	3
Ex-Lands (2s.), Nigeria		2	6		2	3
Geevor (5s.), Cornwall	1	5	0	1	1	6
Gold Base Metals (2s. 6d.), Nigeria		1	3		1	0
Hongkong (5s.), Malaya		4	6		4	9
Jantar Nigeria (3s.)		4	6		4	3
Kaduna Syndicate (2s.), Nigeria		2	0		2	0
Kamunting (5s.), Malaya		12	3		12	9
Malayan Tin Dredging (5s.)	1	1	6	1	4	0
Mawchi Mines (4s.), Burma		2	3		1	9
Naraguta Extended (5s.), Nigeria		1	3		1	0
Pahang (5s.), Malaya		6	0		6	6
Siamese Synd. (5s.)		8	3		9	3
South Crofty (5s.), Cornwall		5	0		5	0
Southern Kinta (5s.), Malaya	1	5	6	1	8	0
Southern Malayan (5s.)		14	6		16	0
Southern Tronoh (5s.), Malaya		12	9		13	6
Sungei Besi (4s.), Malaya		10	9		12	6
Sungei Kinta, Malaya		14	6		14	6
Tekka (12s. 6d.), Malaya		4	9		4	6
Tronoh (5s.), Malaya		15	9		18	9
United Tin Areas (2s. 6d.), Nigeria		—			1	0

DIAMONDS:

	£	s.	d.	£	s.	d.
Anglo American Investment	14	12	0	15	0	0
Consol African Selection Trust (5s.)	1	1	9	1	4	3
Consolidated of S.W.A. Pref. (10s.)		11	0		11	3
De Beers Deferred (5s.)	8	10	9	8	13	6

FINANCE, Etc.

	£	s.	d.	£	s.	d.
African & European (10s.)	4	6	6	4	8	6
Anglo American Corporation (10s.)	9	16	0	10	1	3
Anglo-French Exploration		—			—	
Anglo Transvaal 'A' (5s.)	2	3	9	2	3	9
British South Africa (15s.)	4	13	6	4	13	6
British Tin Investment (10s.)	1	1	6	1	1	6
Broken Hill Proprietary	2	13	0	2	16	0
Camp Bird (10s.)		12	6		12	6
Central Mining	3	17	6	3	17	6
Central Provinces Manganese (10s.)	1	10	0	1	9	3
Consolidated Gold Fields	3	19	0	4	4	0
Consolidated Mines Selection (10s.)	2	4	9	2	4	6
East Rand Consolidated (5s.)		1	9		1	9
Free State Development (5s.)		11	0		9	9
General Exploration O.F.S. (2s. 6d.)		6	3		6	0
General Mining and Finance	7	0	3	7	1	3
H.E. Proprietary (5s.)	1	5	0		—	
Johannesburg Consolidated	3	7	6	3	8	3
London & Rhod. M. & L. (5s.)		8	6		8	6
London Tin Corporation (4s.)		9	3		9	9
Lydenburg Est. (5s.)		16	6		18	3
Marsman Investments (10s.)		1	10½		2	7
National Mining		2	6		2	6
Rand Mines (5s.)	5	3	9	5	2	6
Rand Selection (5s.)	3	0	6	2	18	6
Rhodesian Anglo American (10s.)	4	3	0	4	3	9
Rhodesian Corporation (5s.)		3	6		3	3
Rhodesian Selection Trust (5s.)		14	6		15	0
Rio Tinto (10s.)	2	7	0	2	5	0
Selection Trust (10s.)	5	15	9	5	17	6
South West Africa Co. (3s. 4d.)		15	0		17	6
Union Corporation (2s. 6d.)	3	9	6	3	15	6
Vereeniging	6	15	3	6	13	9
West Rand Inv. Trust (10s.)	3	2	6	3	5	0

THE MINING DIGEST

A RECORD OF PROGRESS IN MINING, METALLURGY, AND GEOLOGY

In this section abstracts of important articles and papers appearing in technical journals and proceedings of societies are given, together with brief records of other articles and papers ; also notices of new books and pamphlets and lists of patents on mining and metallurgical subjects.

Progress in Pebble Milling

A review of " Recent Developments in Pebble Milling," by B. S. Crocker, appears in *Mining Engineering* for May and the following notes have been abstracted. The author suggests that the term pebble milling could apply to fine autogenous grinding in which the pebbles are made from the ore itself, or it could also refer to grinding with pebbles, such as flint pebbles, from a source outside the mine. He says that the first mill to use *screened* ore to grind the ore (1949) was Lake Shore Mines. Pebbles were screened from the jaw-crusher discharge and used in 5 ft. by 16 ft. tube-mills which had been converted to 6 ft. 8 in. by 16 ft. grate-discharge pebble-mills. In 1957–58 the writer was successful in converting the grinding plant of Renabie Mines, in northern Ontario, to autogenous grinding.

In these plants the existing grinding equipment was converted, usually by expanding the diameter of the shell to make the change from steel grinding to ore-pebble grinding mills. Primary grinding was done in either small rod-mills or ball-mills. These mills first reduced the pebble-mill feed to about 6 mesh. The final grinding in the pebble mills varied from 75% *minus* 200 mesh to 92% *minus* 325 mesh. At Lake Shore three stages of pebble milling were used, with a different-size pebble in each stage.

The first new mill designed to use screened ore as a grinding medium was the Bicroft mill, at Bancroft, Ontario, which began operation in 1956. In 1957 this plant was followed by similar installations at Faraday Mines, also in the Bancroft area, and the North Rankin Nickel Mines, in the North-west Territories. In 1958 the Dyno mill at Bancroft was converted, using the same type of grinding.

It is often commented that this type of autogenous grinding applies only to hard siliceous ores. Experience has shown that this is not so. Another frequent objection is the belief held by some operators that there is too much variation in the hardness of their particular ore to make it acceptable as a source of pebble media. Experience has also shown that this is not a serious problem at all.

The use of hard pebbles for grinding ore is not, the author points out, a new metallurgical practice. The contribution Lake Shore Mines made to autogenous grinding was to show a money-saving method of obtaining the pebbles (by screening them out of the jaw-crusher discharge) with complete, quick, and easy control of pebble size. The grinding medium now represents a saving in the amount of ore that has to be crushed and at the same time represents an increase in the tons of ore milled per day. In these circumstances grinding with ore pebbles is more efficient and much more economical than grinding with steel balls. The Lake Shore test work and final plant operation clearly demonstrated that power used to grind the ore is exactly the same for ball-milling as it is for grinding with the correct size of ore pebbles and under properly-controlled conditions. The pebble mills are usually designed to be larger in diameter than the steel mills and in this manner the same number of foot-pounds or the same amount of horsepower is developed.

The average pebble, the author says, in the pebble load should be the same weight (not the same size) as the optimum size of steel balls. An empirical formula has been developed to relate the size of the screen used in sizing the rock feed to the size of pebble in the mill. At recent plants the rock feed has been screened in the crusher house through 2¾-in. or 3-in. square-mesh screen and retained on 1½-in. square-mesh screen. The *minus* 3 in. *plus* 1½-in. screen combination gives a rock feed with a weighted mean size equivalent to a 2-in. pebble, after rounding up in the mill. The *minus* 2¾-in. *plus* 1½-in. screen will give a weighted mean size equivalent to a 1½-in. pebble. A 2-in. pebble is equivalent to a 1·4-in. steel ball and a 1½-in. pebble is equivalent to a 1·1-in. steel ball.

In South Africa the primary grinding is done in mills which are fed with large pebbles—about the size of a man's head—hand picked by natives and fed into the mill from a wheelbarrow. Up to the present time no completely satisfactory means of eliminating the wheelbarrow has been devised. The primary step, therefore, in all these grinding plants is to employ a small rod-mill using 12% to 20% of total horsepower for wet grinding, to reduce the *plus* ¾ crusher product to about 6 mesh. These small rod-mills are run in open circuit and have proved very easy to operate.

The new plants—such as, Bicroft, Faraday, and Dyno—are almost completely automatic. When the pebble mill is started up the pebble-feeding equipment is also started. The pebbles are automatically weighed in batch lots and fed into the mills at predetermined intervals. By watching the kilowatt-demand meter used on these mills and varying the pebble-feed rate the operator can easily control the power being developed by the mill. This easily-regulated power can also be used to vary the overall grind in the circuit. As a pebble load can be changed much more quickly than a steel load there is a much

greater degree of control available to the operators in these pebble grinding mills than in conventional ball-mills. In South Africa Mr. J. Williamson has recently proposed a control device in which the rate of feeding pebbles to the mill can be regulated to maintain a constant amount of power. This is a further improvement on the control of grinding in these circuits.

Capital outlay for a modern pebble grinding plant of the type described above is only slightly higher than for an all-steel grinding plant and further experience in design is continually lowering the cost. The chutes and the pebble-feeding arrangements are extra for these plants. The pebble mills themselves are larger in diameter than steel mills of equal capacity, but they can be made of lighter materials, as the load is actually lighter. Also the steel mills must be supplied with an initial load of grinding balls. The steel mill, together with this initial ball load, costs about the same as the larger-diameter pebble mill. When the cost of the customary four months' to six months' supply of grinding balls, together with storage bins and loading hoppers, is taken into account, the overall cost of the pebble grinding plant is not much greater than for the conventional steel plant.

On the conversion jobs the capital cost of the conversion was realized out of the operating savings in one or two years after the changeover was completed.

In autogenous grinding with sulphide ores allowances must be made for the heavier specific gravity of the ore. Experience has shown, however, that the more siliceous part of the ore is usually harder and therefore tends to build up in the pebble load, so that the final specific gravity of the grinding medium is often lower than that of the ore itself. This must be carefully evaluated in the test work, as the heavier the grinding medium the greater the capacity of a given mill. The chemical action within the grinding mill is also different from that experienced within the grinding mills using steel media ; the action is usually less reducing. This is a very definite advantage in cyanide plants or uranium-leach plants. It is not a disadvantage in flotation plants but may call for a slight change in the conditioning technique prior to flotation.

It is imperative, therefore, to run laboratory-test work on flotation ores, using the ore pebbles in the laboratory grinding mills. This can be accomplished quite easily in any laboratory equipped to do flotation testing and it should be carried out during the preliminary test work so that the prospective client is free to choose any method of grinding with the assurance that the overall metallurgy will not be prejudiced.

Because the pebble plants are more flexible than the plants equipped with steel grinding balls their efficiency is greater. For mills that are filled with steel balls six to eight weeks are needed to change the ball size in the mill completely, to say nothing of the six months' supply of balls usually on hand, which would have to be used up before a new size of grinding ball could be introduced into the mill. Also if the operator wished to change to a smaller size of grinding ball he would usually find that he had to pay a greater price for the smaller ball. These factors discourage most mill men from even attempting to change the grinding medium to suit changes in tonnage or changes in the plant's fineness of grind. In the pebble-grinding layout, however, the operator can increase or decrease the size of grinding medium to suit conditions simply by changing one screen in the crusher house and the pebble load is completely changed in two to four days. Here is a degree of control that opens up new fields in grinding efficiency.

Recently, the author says, R. T. Hukki called attention to the benefits to be derived from running autogenous fine-grinding mills at supercritical speeds. Some interesting results have been obtained in Finland along these lines. Excessive steel consumption was one of the chief objections to running ball-mills at high speeds. However, in autogenous grinding extra pebble consumption is an advantage rather than a disadvantage and higher speeds are much more attractive. This is an interesting new field of operation which should be studied thoroughly.

Novel Platform for Loading Mine Cages

In the July issue reference was made to a new type of loading chute designed by Mr. R. Blair, consulting mechanical engineer to the Anglo American Corporation of South Africa, Ltd. In the September issue of *Optima*, the quarterly review published by the Corporation, there is a description of a further development designed by the same engineer, this time of a new floating loading platform, the installation of which, in mines in South Africa and elsewhere, is expected to result in greater safety in conveying men and materials to and from underground shaft stations and an economy in winding time. The object of the floating platform is to compensate automatically for the stretching of the steel rope on which a cage is suspended in a shaft.

When a load is placed in a cage at a loading station several thousands of feet underground the rope stretches and allows the cage to descend as the load increases and this complicates the loading procedure. When a truck is half-way into the cage the latter descends because the weight has stretched the rope. If no corrective action were taken the truck would become jammed in this position. The normal procedure, therefore, is for the winder-engine driver operating the hoist on the surface to raise the cage a little until the truck can be run fully into the cage. The difficulty of this operation, it is suggested, will be apparent for, when the back wheels of the truck enter the cage the full weight is taken by the rope ; and unless very accurate corrections are made by the winder-engine driver the tail of the truck may foul the edge of the loading platform before the truck passes fully within the cage.

The same problem is met in reverse when a load is transferred from the cage to the loading platform, for the stretched rope then contracts and raises the

cage. Again this calls for careful operation of the hoist. The problem is even more serious when men are entering or leaving the cage, for the movement of the cage above or below the platform leaves a dangerous gap.

The danger of an accident when men are moving between the platform and the cage and the difficulty of transferring a truck or other material are eliminated by the use of the floating platform, for the platform moves automatically to keep it exactly in line with the cage while it is being loaded or unloaded.

The platform is supported by a pillar, whose movement is controlled by hydraulic pressure ; in its normal position it is at the highest point of its travel. Projecting into the shaft from the end of the platform are two levers which, when they are depressed, control a valve to by-pass some of the fluid in the hydraulic system and thus allow the platform to sink to a lower level. As the truck enters the cage the rope stretches and allows the cage to descend, but the tipping rollers (one on each side of the cage) depress the valve-control levers and cause the loading platform to sink, keeping in line with the cage. This movement is continuous throughout the loading operation.

Exactly the same action takes place when men step off the loading platform into the cage. No gap can occur between the platform and the cage and the transfer is carried out with complete safety.

When a loaded cage is lowered so that men or materials can be transferred to the platform the action takes place in reverse. The cage is lowered to the full extent to the normal calibrated mark on the hoist indicator. As the rope is stretched by the tension caused by the load in the cage the cage will come to rest and take the loading platform down with it as it passes the normal-loading position for an empty cage. As the load is transferred to the loading platform both the cage and the platform will rise, for as the load leaves the cage the stretching of the rope will decrease, causing the cage to rise and removing the pressure on the valve-control levers and thus allow the hydraulic system to lift the loading platform in line with the cage. Again this movement is smooth and continuous and does not allow any gap to occur between the platform and the cage.

In addition to the increase in safety this system considerably reduces the time taken to load or unload a cage, because it eliminates the adjustments that have normally to be made by the hoist.

Canadian Uranium

In a review of the Canadian uranium industry during 1958, which appears in the *Western Miner and Oil Review* for August, the author, J. W. Griffith, suggests that the outstanding feature of the year in the uranium industry was the spectacular increase in production which put uranium in top place among the metals produced in Canada. The output (13,461 tons of uranium oxide) was double what it was in 1957 and its value ($277,552,876) was greater than that of any other metal produced in Canada during 1958. Canada ranked first among the world producers of uranium. Other leading producers, in descending order of output, were : the United States, the Union of South Africa, the Belgian Congo, Australia, France, Portugal, and probably the Soviet Union.

Canadian production was from mines in the Elliot Lake (Blind River) district of Ontario (69% of the total), the Lake Athabasca region of northern Saskatchewan (21%), the Bancroft area of Ontario (7%), and the North-west Territories (3%).

All the uranium mines in the Elliot Lake district which hold contracts with Eldorado Mining and Refining, Ltd., reached production in 1958. During the year 25 mines and 19 concentrating plants were in operation throughout Canada. The total milling rate of the industry at the end of 1958 was about 42,000 tons of ore a day. The increase in output is expected to level off in 1959 when all plants now in operation should reach full production. Although the plants are capable of producing in excess of the rated capacity the anticipated annual rate of production will be 15,500 tons of uranium concentrate.

The reserves of measured, indicated, and inferred ore in Canada at the end of 1957 were estimated at 376,888,000 tons with a uranium-oxide content of 414,577 tons. This is considered to be the largest proved reserve of uranium in the world. The ore reserves in the Elliot Lake district constitute about 94% of the total ore reserves in Canada. The Beaverlodge area of Saskatchewan and the Bancroft area of Ontario each contain about 3% of the country's reserves.

The Rio Tinto Mining Co. of Canada, which controls seven of the 11 producing mines in the Elliot Lake camp, joined with certain other companies in the formation of Rio Tinto Dow, Ltd., to build a thorium-recovery plant adjacent to the Quirke mine. Algom Uranium Mines and other associated uranium-oxide producers will supply waste liquors from the uranium-recovery plants for the recovery of thorium and rare earths. The thorium plant, the first in Canada, is expected to be in production early in 1959. Full production, at the rate of 100 tons to 200 tons of thorium salts annually, is expected to be reached in July, 1959.

The ore reserves of the Elliot Lake and Bancroft areas are estimated to contain 250,000 tons of thorium (ThO_2). At the present rate of uranium production in these camps it would be possible to recover annually between 2,500 tons and 5,000 tons of thorium salts as a by-product.

No new discoveries of uranium were reported in 1958 in Canada and practically no prospecting was undertaken in new areas. Some of the operating mines carried out underground exploration and development during the year. The main reason why new discoveries have been lacking since 1956 is that the market for additional uranium has been limited.

Both Eldorado and Rayrock carried out extensive underground exploration and development at their mines in the North-west Territories. Ore reserves at both of these mines are rapidly diminishing. Rayrock deepened its shaft to two new levels and an area to the north-east of the main ore-body was explored from the third level.

Belleterre Quebec Mines completed about 3,000 ft. of diamond drilling on a highly-radioactive occurrence near Lake Kipawa, Quebec, about 60 miles north-east of North Bay, Ontario. Much staking

and prospecting were done in this area in 1957 and 1958, but by the end of 1958 all work had been suspended. The principal radioactive occurrences on the Belleterre property consist of small discontinuous lenses of uraninite and other valuable minerals in a band of micaceous quartzite.

British Newfoundland Exploration has developed a high-grade uranium deposit near Kaipokok Bay, on the Labrador coast. Up to May 15, 1958, the ore reserves calculated from diamond-drill intersections were 206,000 tons grading 0·709% U_3O_8 (uncut). Diamond drilling and underground exploration were begun in September, 1957, and have continued intermittently up to September, 1958. Prospecting, geological mapping, and diamond drilling were done on other showings in the area during 1958.

The United States continued to be the major market for Canadian uranium, but agreements were concluded to supply uranium to the United Kingdom beginning in July, 1958. The United Kingdom agreed to buy uranium valued at $115,000,000 from Canada during the period from July, 1958, to March 31, 1962. This allotment will be diverted from existing contracts with the United States. Arrangements were also made with the United Kingdom Atomic Energy Authority whereby it will obtain an additional quantity of uranium from Canada valued at $105,000,000. The delivery of this quantity will be made over the period from April 1, 1962, to March 31, 1963, by a diversion from quantities now under contract which are scheduled for delivery in that period. Arrangements are being made to supply the United Kingdom with uranium over the period from April 1, 1963, to December 31, 1966. Supplies for this purpose will come from quantities under option in the present purchase contracts. The Government of the United States has options to purchase Canadian uranium up to December 31, 1966.

Canada has also concluded agreements for the sale of uranium to the Federal Republic of Germany and to Switzerland. Negotiations are under way for sales to Japan and certain nations of Western Europe. Canada is also endeavouring to negotiate a treaty with EURATOM to provide for the co-operative exchange of information on the peaceful uses of atomic energy and for the supply of material, particularly uranium.

In May, 1958, Canada amended its purchasing policy to permit private producers to make their own arrangements for the sale of surplus uranium under certain conditions. Permits may be issued to a private producer to allow him to make individual sales of up to 250 lb. for use in testing and research, but the total of such sales to any one country must not exceed 2,500 lb., unless the government of the recipient country has entered into an agreement with the Canadian Government for co-operation in the peaceful uses of atomic energy.

Defence purchases, the author says, continue to dominate the market for uranium. However, commercial requirements for peaceful purposes have recently assumed significant proportions throughout the world. Nuclear reactors for the production of electricity and heat and for research purposes are under construction in many countries of the world, particularly in Great Britain, Europe, and the United States.

Eldorado Mining and Refining has been refining uranium at Port Hope, Ontario, since 1935. The company produces uranium metal and uranium compounds of consistent quality and the highest purity. Through its facilities and those of associated companies the metal can be supplied in the form of machined ingots, forged and rolled shapes, and completely fabricated fuel elements. Uranium-dioxide fuel elements of ceramic grade can also be supplied.

Falconbridge Geology

The issue of the *Canadian Mining Journal* for June contains a series of articles regarding Falconbridge Nickel Mines, from one of which the following notes on the geology of the area have been abstracted. As will be well known the Sudbury nickel-copper sulphide ores are closely associated spatially and genetically with a late Precambrian intrusion known as the nickel irruptive, or simply as the irruptive. This formation, unique in the area, lies about mid-way along the north edge of a belt of late Precambrian rocks that sweeps in a north-easterly direction from the east end of Lake Superior to the Ontario–Quebec boundary. As exposed on surface the irruptive varies in width from one to two miles and forms an asymmetric ellipse about 37 miles long and 17 miles wide, whose long axis conforms with the regional north-easterly geological trend. It is composed of an inner layer of micropegmatite separated by a transition zone from a somewhat narrower outer layer of norite. For most of its perimeter the irruptive dips inward at 30° to 50°. However, on its south margin near the east end the dip is generally steeper and, in places in the Falconbridge mine, it has been found to dip steeply outward.

From the outer rim of the irruptive a number of dykes, known locally as " offsets," extend outward into the surrounding footwall rocks for distances of up to five miles. These dykes are believed to be closely related to the irruptive in origin and, although their strikes are widely divergent, they all have steep dips. The largest and most persistent of these dykes are known as the Copper Cliff, Worthington, and Foy offsets.

On the west, north, and east the norite is bounded by pre-irruptive granite, granite gneiss, and granitized rocks. To the south lies a succession of pre-irruptive volcanics and sediments which strike in a general north-easterly direction, dip steeply north, and face south. Three bodies of granitic rocks, younger than the volcanic-sedimentary series, contact the south margin of the norite. Although they are mainly pre-irruptive in age there is evidence that some of the granite is post-irruptive. Most of the formations to the west, south, and east of the irruptive have been invaded by diabase and gabbro dykes and sills which show a marked tendency to follow planes of weakness established prior to their intrusion.

Breccia zones of undetermined origin occur in the foot-wall rocks surrounding the irruptive. They contain fragments of all the pre-irruptive rocks of the area ranging in size from small particles to immense blocks. Much time has been devoted to

the study of the Sudbury breccias, but the way in which they were formed and their geological age remain obscure. It is generally accepted, however, that they were formed during a period of severe crustal disruption accompanied by volcanism at a time prior to deposition of the ore and probably prior to the intrusion of the norite.

The irruptive is overlain by the three members of the Whitewater series of sediments. Nothing is known of the original extent of the area covered by the rocks of this series and no evidence of them is found beyond their contact with the upper, or micropegmatite edge, of the irruptive.

The youngest rocks in the area are intrusions of trap, aplite, and olivine diabase in the form of dykes. They are post-irruptive and mainly post-ore in age.

In this geological setting the Sudbury ore-bodies, excepting the offset deposits, occur as concentrations of sulphides at, or adjacent to the lower contact of the norite. Weak mineralization is present along most of this contact, but the occurrence of sulphides in sufficient concentration to be of economic importance appears to have been influenced by structures that existed at and adjoining the base of the norite before the sulphides were emplaced. The more important of these structures appear to be embayments and depressions in the foot-wall rocks and zones of shearing or brecciation coinciding with or adjoining the foot-wall contact of the norite. The offset dykes are generally weakly mineralized and concentrations of sulphides within them appear also to have been controlled to some extent by structural features such as pinches and swells in the dykes and by intersecting zones of brecciation.

The sequence of volcanic and sedimentary rocks lying south of the irruptive forms the overturned south limb of a major anticline. It has been suggested that transverse arching of the anticline in the present location of the Sudbury basin produced a weakening of the crustal rocks, which under deep-seated pressure resulted in volcanism followed by intrusion of the nickel irruptive.

The Onaping tuff shows evidence of volcanic activity at the time of its formation. It is generally agreed that the tuff pre-dates the irruptive but the time interval between them is difficult, if not impossible, to determine. It seems probable, however, that the crustal ruptures which formed the volcanic vents also tapped the magma source of the irruptive and, if so, the time interval may have been relatively short.

Other than displacement of the irruptive along faults little is known of the extent to which it has been deformed since it was intruded. Some of the faults in the area pre-date the irruptive and, in places, appear to have controlled the location and dip of its outer edge. On many of these early faults there has been post-irruptive and, in some cases, post-ore movement. There are indications that some movement took place while the rocks of the irruptive were still plastic as is shown in places by faulting at the outer margin of the norite. Faulting of this type penetrates only a short distance into the irruptive before fading and becoming obscure.

On the basis of their strikes, dips, and displacement the important faults of the area fall into one or another of five categories or families. Many of the multitude of lesser faults may be similarly grouped by reason of their strikes and dips.

Members of the first set of faults strike east and west and are nearly vertical in dip. They are most prominent in the foot-wall rocks south of the irruptive and are exemplified by the Worthington, Pump Lake, and Creighton faults. Movement on these faults is right-hand and the amount of displacement on them is greatest on the most southerly faults and decreases progressively on individual faults from south to north. The " main fault " in Falconbridge mine may be a member of this group.

Faults of the second group, of which the Cameron Creek fault is an example, strike N. 50° E. They are assumed to be high-angle thrust faults with little horizontal displacement and may be related in origin to the forces which resulted in the formation of the Grenville thrust front. The latest movement on them is post-ore in age.

Faults of the third set strike N. 20° W. and include the Fecunis Lake and Sandcherry Creek faults along both of which the irruptive has been displaced. They dip steeply to the west and the displacement on them is left-hand with some indication of overthrusting from the west.

Faults of the fourth set strike N. 45° E. and dip steeply north-west. The Creighton mine shear is the best example of faults of this group.

Faults of the fifth set have a common north-westerly strike and dip steeply to the north-east. Evidence of faults with this dip and strike is found in both the Falconbridge and Hardy mines where they appear to have had some control on the deposition of ore.

Trade Paragraphs

Crofts (Engineers), Ltd., of Bradford, in two new leaflets call attention to their geared motors for 1 h.p. to 20 h.p. and hydraulic couplings and drives available from stock for transmission up to 100 h.p. at 1,450 r.p.m. but also available up to 700 h.p.

Keelavite Hydraulics, Ltd., of Allesley, Coventry, have appointed Holman Bros. (Pty.), Ltd., P.O. Box 6218, Johannesburg, as their agent for the sale of hydraulic equipment in South Africa and Rhodesia. Holman Bros. are manufacturing hydraulic cylinders under licence from Keelavite.

British Ropeway Engineering Co., Ltd., of Plantation House, Mincing Lane, London, E.C. 3, announce that Mr. Alex Dewar has been appointed their agent for the whole of Scotland, at Green Bank, Cumnock, Ayrshire. He succeeds the late Mr. John Thomson and was formerly with the National Coal Board.

Thos. W. Ward, Ltd., of Albion Works, Sheffield, have produced a 70-page, fully illustrated booklet setting forth the products and services offered by the Ward Group of companies, covering contractors' plant, cranes, machinery, railway plant, industrial plant, iron and steel scrap, etc.

Engelhard Industries, Ltd., Hanovia Lamps Division, of Slough, Bucks., now have in production a new 2 kW suspension fluorescence lamp which has been developed for the engineering industry for use in the non-destructive testing of larger components by fluorescent-ink methods.

Inspection Services, Ltd., of Oldfields Trading Estate, Sutton, Surrey, and R. F. Fraser-Smith,

formerly of 69, King's Cross Road, London, W.C. 1, announce that they have merged their interests. Inquiries for non-destructive testing equipment should in future be addressed to the first-named company.

Cyanamid International, of 30, Rockefeller Plaza, New York, with reference to the note which appeared in the September issue on their Aerozanthates point out that these are styled AERO Xanthates and also that reference should have been made to the higher bulk density of these reagents—not higher bulk chemistry.

Goodyear Tyre and Rubber Co. (Great Britain), Ltd., of Wolverhampton, in their *Industrial Rubber News* for September, have an article on hoses for special purposes—*e.g.*, air, sandblast, oxygen, acetylene, and petroleum gas. There are some notes with illustrations on running-in V-belts and a brief review of the company's role in the Canadian uranium programme.

Richard Sutcliffe, Ltd., of Horbury, Wakefield, announce the appointment of Mr. Matthew Reid Moore as manager of their mining and general products division. He joined the company shortly after the war and for the last ten years has been their district technical manager for the N. and C. and Durham Divisions of the N.C.B. and industrial representative for the North of England.

Sturtevant Engineering Co., Ltd., of Southern House, Cannon Street, London, E.C. 4, who last November started a cathodic protection department, have now issued a booklet on the subject. This deals with theory, practice, corrosion prevention, and cathodic protection, including current density required. The booklet points out the two different methods for generating current and gives details of the material and equipment needed.

George Angus and Co., Ltd., of 152–8, Westgate Road, Newcastle-upon-Tyne, issue a leaflet describing their Gaflex nylon wefted conveyor belting, available in three types—standard, super, and plus—each designed for a particular range of duties. Among features indicated are higher impact resistance, greater tear resistance, ability to sustain load through a mechanically-fastened joint, good troughing characteristics, and good flexing life.

R. and J. Dick, Ltd., of Greenheed Works, Glasgow, S.E., have produced a catalogue of their Dixylon plastic transmission belting for high-speed drives which is described as stretchless, silent, smooth running, and easily made endless. In addition to the standard belting there is the Suplex oil-resisting belt and the anti-static variety for use in the presence of inflammable vapours and explosive dusts. Useful tables for transmitted horsepower calculations are included, as well as details of accessories like skivers and presses for splicing.

Johnson, Matthey and Co., Ltd., of 73–83, Hatton Garden, London, E.C. 1, in a recent announcement state that their associate company—Universal-Matthey Products, Ltd.—has formed a subsidiary in Cologne—Universal-Matthey Products (Deutschland) GmbH—with a nominal capital of DM 20,000. The object of this new enterprise is the manufacture of platinum catalysts to meet the needs of petroleum refineries employing the UOP Platforming process in Western Germany and the Common Market countries.

Edgar Allen and Co., Ltd., of Sheffield, have been granted the sole licence for the manufacture and sale in this country of Bamag resonance screens. This recent development in screening machinery is at the moment relatively uncommon in this country when one considers the wide range of possible applications. Pintsch Bamag, of Germany, have largely contributed to the development, installation, and subsequent proving of resonance screens on the Continent, where they are now generally accepted as the most up-to-date and efficient form of vibrating screen.

F. E. Weatherill, Ltd., of Welwyn Garden City, Herts., have introduced two new standard versions of their 12H and 14H shovels designed for soft-ground conditions. In the 14H extra power is provided by a 62-b.h.p. Fordson diesel engine and a Brockhouse torque converter with special oil cooler, fully-automatic gearbox, and improved power-assisted steering are now fitted as standard. The 12H model is also available with the torque converter, oil cooler, gearbox, and power steering as optional extras and, like the 14H, is fitted with special wide tyres which help considerably when operating on soft ground.

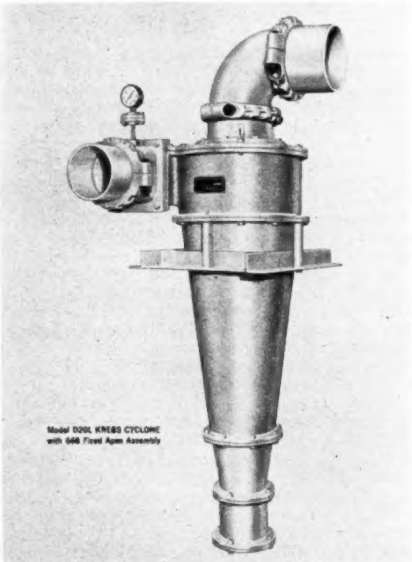
Head, Wrightson and Co., Ltd., of Stockton-on-Tees, have produced two illustrated booklets. One of these describes the services they are able to offer and the plant they make for the steel industry. The other, described as engineering for world industry, gives particulars of a range of their products—such as, petroleum and chemical equipment, nuclear research and power plant, coal preparation plant and equipment, aluminium fabrication, mining equipment (headframes, dryers, ball-mills, etc.), iron and steel castings, and forgings. The text in each case is in English, French, German, and Spanish.

Murex Welding Processes, Ltd., of Waltham Cross, Herts., announce that they have purchased the whole of the issued shares of Donald Ross and Partners, Ltd., Crawley, Sussex, specialists in the design and manufacture of mechanical aids to production and, in particular, the well-known "Twinner" positioners for hand and automatic welding. While Donald Ross and Partners will continue to operate as in the past and under the same name and the same management, this association will enable both companies to offer individually and jointly a first-class specialist service to users of welding and to companies contemplating installation of mechanical aids to production.

International General Electric Co. of New York, Ltd., of Lincoln House, 296–302, High Holborn, London, W.C. 1, make available some notes on a portable silicon mine power supply unit, comprising a rectifier car and a transformer car, which is only 30 in. high. The Low-Boy, as it is known, is available for ratings from 300 to 750 kW (275 to 550 volts d.c.). The rectifier car contains silicon diode compartments, cooling fan, and d.c. switchgear consisting of automatic reclosing equipment, line disconnect and a d.c. contactor. The contactor is specifically designed to withstand the opening and closing operations required in mining service. The transformer is a sealed dry-type construction, using sulphir hexafluoride, as a cooling and insulating medium.

Neldco Processes, Ltd., of Crossways House, Bracknell, Berks., announce that they have been appointed sole agents for the sterling area for Krebs cyclones. It is recalled that the Krebs organization began intensive research into cyclone design in 1950. Since then many hundreds of their installations have been made throughout the world. These cyclones differ from others in that they have a long-sweep involuted feed entry which, in terms of relative

performance, increases capacity 25% beyond its cylinder-diameter rating. This type of entry produces a flow pattern totally different from that in conventional cyclones and short circuiting, with its resultant inaccuracies, is eliminated, it is pointed out. The great variety of Krebs cyclones with interchangeable orifices available makes it simple to suit the installation to the job.



J. E. Lesser and Sons, Ltd., of Green Lane, Hounslow, Middx., in an illustrated leaflet call attention to their Middlesex prefabricated buildings and in particular to bungalow and bachelor units suitable for staff working in isolated areas overseas. Ceilings are flat and constructed from panels and covered with insulation board. Walls are clad on both sides with exterior quality plywood with mineral insulation wool in the cavity. When, however, termites prohibit the use of timber, metal panels of aluminium trough sections with internal lining of Asbestolux can be supplied with frames of steel sections. Roofs are of steel trusses and purlins supported on columns and covered by aluminium sheeting. Prefabricated plumbing and electrical harness units are usually supplied properly packed for shipment..

British Thomson-Houston Co., Ltd., of Rugby, in a recent announcement state that by deciding to sink new shafts at Hucknall No. 2 Colliery the National Coal Board plans by 1961 to raise coal from this pit at the rate of 320 tons an hour from a depth of 1,908 ft. The drive for the winding equipment for the new shafts, to be supplied by the A.E.I. Heavy Plant Division, will consist of a 1,400-h.p. d.c. motor fed by two Type MB6/13G1 pumpless steel-tank mercury-arc rectifiers. At first the winder will have manual closed-loop control, but there will be provision for extension to automatic control in the future. The equipment, which is to be installed in December, 1960, will include a drum 18 ft. in diameter and 13 ft. wide, manufactured by **Robey and Co., Ltd.,** of Lincoln, and the brakes will be of Robey's new high-pressure type.

Le Tourneau-Westinghouse Co., of Peoria, Illinois, have introduced into their range of earth-moving equipment a high-power large-capacity unit called the V-Power C Tournapull which is shown in the illustration teamed with a 20-cu. yd. Fullpak scraper. The new more powerful engine is a 270-h.p., eight-cylinder, two-cycle diesel, which develops its rated horsepower at 2,100 r.p.m. and reaches maximum torque at 1,200. Excellent acceleration is a basic feature, enabling the operator to reach his haul speed quickly—30% faster than on the standard-powered C. The V-8 engine retains the two-cycle design for low-cost operation and longer engine life ; it has four exhaust valves for each cylinder, making it cool running and ensuring long valve life and economical fuel consumption. The step-gear transmission gives five forward speeds to 27 m.p.h. A heavy-duty, 16-in., double-plate, air-assisted clutch is standard. A clutch brake gives fast, easy shifts. The Fullpak scraper is basically the same as was announced recently for the new six-wheel Speedpull. The company have also issued an illustrated booklet which gives particulars of their range of graders, consisting of seven models

Le Tourneau-Westinghouse Tournapull.

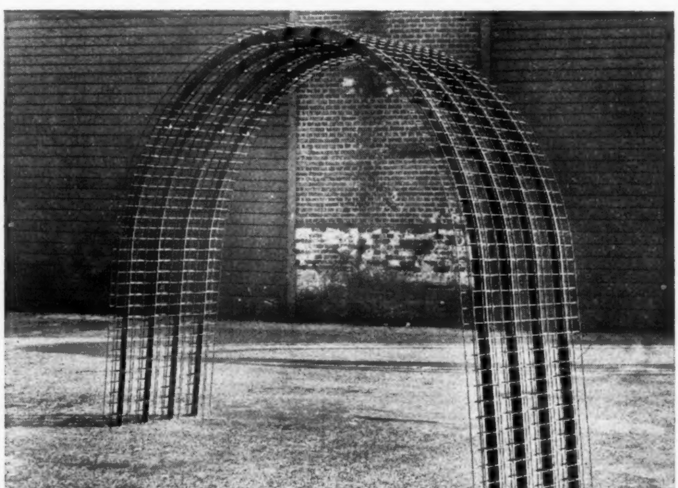
ranging in horsepower from 67 h.p. to 190 h.p. Two Power-Flow models are offered with full torque-converter transmissions. The other graders offer transmissions with eight forward speeds, four reverse, and three optional creeper speeds.

Ford Motor Co., Ltd., of Dagenham, Essex, from their Fordson tractor division issue a note concerning an operation which took place recently at the Kingston-on-Soar gypsum mines, near Nottingham. Gypsum Mines, Ltd., took delivery of a new Fordson Power Major industrial tractor and this was broken down into units small enough to enter the 4 ft. by 4 ft. shaft for lowering, piece by piece, to the bottom. Everything was satisfactorily fitted into the cage, including the wheels which, complete with tyres, had a total diameter of some 44 in. Some difficulty was experienced with the 22-cwt. transmission section. A quarter of a mile from the shaft, the tractor, which will be used for heavy-haulage work, was re-assembled by the light of miners' lamps and a lamp rigged from a 12-volt battery. The tractor is to be fitted with a special filter device to counter the effects of exhaust gases underground.

Baker Perkins, Ltd., of Peterborough, with reference to the appointment of Mr. S. W. F. Patching as manager of their new mineral processing department referred to elsewhere in this issue, state that the appointment follows the signing of an agreement between Baker Perkins and the Ministry of Development of the Government of Israel for the exploitation of a process for mineral-ore dressing and coal preparation, based on the use of a heavy liquid, tetrabromoethane, known as T.B.E. This liquid is extracted from the waters of the Dead Sea by a new and economic process perfected by the Israel Mining Industries. They have also developed a dressing process which is particularly suitable for the enrichment of relatively poor and difficult ores. Baker Perkins will design, build, and sell special equipment for ore-dressing by the T.B.E. process and will market T.B.E. for use in these plants.

Knapp and Bates, Ltd., of 14-17, Finsbury Court, Finsbury Pavement, London, E.C. 2, announce a completely new series of flotation machines. The conventional mechanism has been abandoned in favour of a heavy-duty turret worm-gear unit, featuring their special hollow shaft and enabling 4-pole squirrel-cage motors to be used irrespective of cell size. The new mechanism also avoids the need to mount the motor vertically. Rubber-protected wearing parts—the highly-stressed components of moulded construction—are supplied as standard and hard alloy is available for those who prefer it. The Cells are readily adaptable to supercharge or the use of gases other than air by the use of a ball-bearing swivel valve. Weir control by hand-wheel and worm gear is fitted as standard and the machines can be supplied as singles, twins, or multiple units. The turret worm-gear mechanism is available on the 23 in. by 23 in., 35 in. by 35 in., 47 in. by 47 in., and 59 in. by 59 in. cells.

Causeway Reinforcement, Ltd., of Dover Road East, Northfleet, Kent, refer in some notes they have issued to a new approach to the problem of providing permanent arch supports in mine tunnels where major distortion is unlikely. A careful study of the theoretical problems in conjunction with the practical experiences of mining engineers and mining economists has led to the introduction of two types of arch support which, it is claimed, can reduce installation and maintenance costs and provide protection against the effects of minor distortion. One type of support is a development of the company's Hexmetal cellular reinforcement. The feature of the construction is its honeycomb pattern, in which the strips are linked with patented independent pin joints. The employment of independent pins makes for resistance to corrosion, since the pins, being unstressed, are less prone to corrosion than integral lugs. For rigid structures the honeycomb strips may be riveted or welded. The second type of support is made up of several $2\frac{1}{2}$ in. deep, $\frac{5}{16}$ in. thick, steel flat-girder bars, spaced at any specified interval across the mesh, the standard pattern

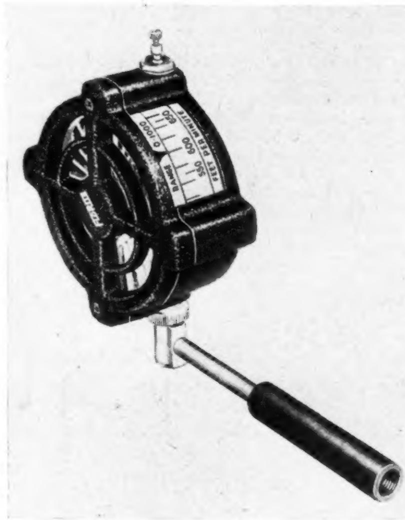


Causeway Mine Arch Support.

having girder bars at intervals of 12 in. (see illustration). Above and below these bars are laid mats of 3 in. square electrically-welded mesh of 6 s.w.g. mild-steel wire. Mesh and bars are secured and locked with 16 s.w.g. clips on either side of each bar. These permit the bars to be clamped to give a rigid frame. The four girder bars have a cross-sectional area equal to that of a 3 in. by 3 in. R.S.J. The wire mesh extends a further $4\frac{1}{2}$ in. at either side of the end girders, giving a total width for the standard fabrication of 3 ft. 9 in.

Quasi-Arc, Ltd., of Bilston, Staffs., refer in some recent notes to increased savings in the maintenance costs of heavy-duty plant that can now be achieved using a new range of hard-facing welding electrodes they have introduced. Known as " Cobalarc," they have been added to the existing group of seven " Duroid " electrodes and provide a complete range of hard-facing products which can be applied to almost any type of plant subjected to weardown. The technique of hard facing—*i.e.*, depositing a wear-resistant surface on to a base metal of mild or alloy steel by arc welding—can therefore be used more widely. The six types of " Cobalarc " electrode are graded according to the properties of the deposit, with resistance to maximum abrasion at one end of the range and maximum impact at the other. In between the deposits combine varying degrees of impact and abrasion resistance, as well as resistance to corrosive liquids, oxidation, etc. The deposited alloys include tungsten-carbide composites, chromium-carbide austenitic irons, cobalt- and nickel-base alloys, and martensitic, pearlitic, and austenitic steels. Fields of application for these products include the quarrying, dredging, earth-moving, mining, cement, iron and steel, chemical, and gas and power industries.

Shandon Scientific Instrument Co., Ltd., of 6, Cromwell Place, London, S.W. 7, announce the recent introduction into this country of two new anemometers—the Florite, a bridled vane instrument as illustrated, and the Floret, which is a small pocket indicator. The Florite is a circular instrument with a die-cast housing, 4 in. in diameter and $1\frac{3}{4}$ in. deep. The rotating peripheral scale, 8 in. long, gives direct readings in feet per minute or miles per hour. No charts, calculations, or other aids are needed. Two scale ranges are available—0–1,000 f.p.m. and 0–3,000 f.p.m., the latter scale also bearing gradations in m.p.h. The readings are automatically averaged over an area 3 in. in diameter and accuracy is guaranteed within 2% of full scale reading. A zero adjustment is provided. The instrument is held to the air flow and the readings taken, the rotor being magnetically damped to level out insignificant variations in velocity and to bring the scale rapidly to rest. A scale lock, released by a spring-loaded trigger, enables readings to be locked on the scale—a really useful feature when the instrument is being used in places where the scale cannot be seen. The lock may be permanently released by turning a screw. A special detachable handle is provided, to which may be screwed a long extension rod for reaching particularly inaccessible places. In such cases the scale lock trigger is easily operated by a cord. Two models are offered ; one for normal use, the other Model MDL fitted with a special scoop for measuring air flow from square or circular ceiling diffusers or louvres. The Floret provides instant direct readings on a $2\frac{1}{4}$ in.-long sector-scale graduated in equal-sized divisions from 0–1,000 f.p.m. It works on the



deflecting vane principle, the air entering through a small hole in the base of the moulded plastic case. A simple positive zero adjustment is provided.

Polypenco, Ltd., of Tewin Road, Welwyn Garden City, Herts., in an illustrated leaflet call attention to the advantages and uses of Nylon 66. This polyamide resin is a thermoplastic having a density less than half of that of aluminium and, although a horn-like material, is resilient and semi-flexible and has a hardness in the range of the white metals. Properties include high resistance to heat and to many chemicals, good insulation, wear and abrasion resistance, and sound absorbing. Gears, brushes, bearings, thrust washers, seals, and gaskets are among the products made from it or from the company's Nylatron—another nylon which has a molybdenum disulphide filling or a graphite filling. Other Nylons are mentioned and their properties. A further leaflet calls attention to a new chemically inert thermoplastic material known as K.51, which is a chlorinated polyether derived from pentaerythritol and possesses an unusual combination of properties for a thermoplastic, including excellent mechanical strength, high temperature resistance, exceptional chemical resistance, and extremely good dimensional stability. Inert to almost all alkalis, solvents, chlorides, and inorganic acids, it has a tensile strength of 6,000 p.s.i. and a Rockwell hardness of R100. It has high resistance to deformation under load and very low cold flow tendency compared with fluorocarbons.

British Nylon Spinners, Ltd., of 68, Knightsbridge, London, S.W. 1, in some recent notes refer to the fact that nylon figures prominently in new types of conveyor-belt which are now being bought on a small scale by the National Coal Board. Under a new scheme designed to encourage the development of belts incorporating man-made fibres the Board has started to grant " limited approval " to selected belts. The majority of the belts in the first batch are made partly from nylon. Nearly all the fully-approved nylon-mixture belts are solid woven. Nylon has been used for this type of belting for

some years past and has proved outstandingly successful. The use of nylon in plied belting, however, is a more recent development and it is on this type of belt that the main interest is focussed since it accounts for the bulk of the B.C.B. purchases.

The notes point out that all the leading British manufacturers of conveyor belting have been carrying out their own investigations into the possibilities of using nylon in plied belting. At the present time interest is centred chiefly on its use as a weft yarn, but this does not preclude its use for the warp also. Experimental belts made from all-nylon ducks were, in fact, shown by the company at the recent Mining Machinery Exhibition (see June issue). The immediate need to improve the weft strength of conveyor belting was underlined by a recent report prepared after field investigation. This pointed out that belting seldom if ever " wears out " but is discarded because of accidental damage. It added : " It is apparent that the damage to the weft threads is a more important reason for the removal of belting than the damage to the warp threads " and concluded by making a strong recommendation for improvements in the lateral strength of belting. The majority of belting manufacturers consider that the use of nylon offers the most attractive means of achieving this greater weft strength. The yarn has a tenacity of 8·8 grams. per denier and is substantially stronger than any other textile yarn which can be used for the purpose. This yarn, 840 denier Type 600, was in fact developed by the company in 1956 specially for belting and tyre cords. Besides its strength it has a number of other properties which make it attractive for belting—greater shock strength and abrasion resistance, high flex strength and wet strength, and it cannot rot.

RECENT PATENTS PUBLISHED

☛ A copy of the specification of the patents mentioned in this column can be obtained by sending 3s. 6d. to the Patent Office, Southampton Buildings, Chancery Lane, London, W.C. 2, with a note of the number and year of the patent.

17,565 and 17,682 of 1955 (818,615–6). ILLINOIS CLAY PRODUCTS CO. Method of strengthening iron ore agglomerates.

24,980 of 1955 (817,954). PHILLIPS PETROLEUM CO. Re-cycle control of pellet mill for powdered materials.

29,083–5 of 1955 (818,379–80). ELECTROLYTIC METAL CORPORATION (PTY.), LTD. Preparation of manganese solutions and electrolytic recovery of the metal.

32,308 of 1955 (818,622). J. B. KASEY. Method of treating rare earth ores.

8,652 of 1956 (818,179). WESTINGHOUSE ELECTRIC INTERNATIONAL CO. Zone refining of metals.

15,651 of 1956 (818,236). C. A. TAYLOR. Method and apparatus for the reduction of metal oxides.

24,684 of 1956 (818,002). IMPERIAL CHEMICAL INDUSTRIES, LTD. Manufacture of titanium.

6,917 of 1957 (817,916). Blast-furnace smelting of zinciferous materials.

7,724 of 1957 (818,625). O. ROLFSEN. The production of ball-like nodules of fine-grained ores and minerals.

NEW BOOKS, PAMPHLETS, ETC.

☛ Publications referred to under this heading can be obtained through the Technical Bookshop of *The Mining Magazine*, 482, Salisbury House, London, E.C. 2.

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Tunnel Engineering. By ROLT HAMMOND. Cloth, octavo, 332 pages, illustrated. Price 55s. London : Heywood and Co., Ltd.

Oil on Stream ! A History of Interstate Oil Pipe Line Company, 1909–1959. By JOHN L. LOOS. Cloth, octavo, 411 pages, illustrated. Price $6·00. Baton Rouge 3, La. : Louisiana State University Press.

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Fiji : Geology of North Tailevu, Viti Levu. Geological Survey Bulletin 1. By R. E. HOUTZ. Paper covers, 19 pages, illustrated, with map. Price 10s. Suva, Fiji : Geological Survey Department.

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Selected Index to Current Literature

This section of the Mining Digest is intended to provide a systematic classification of a wide range of articles appearing in the contemporary technical Press, grouped under heads likely to appeal to the specialist.

* Article in the present issue of the MAGAZINE. † Article digested in the MAGAZINE.

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Economic, United States : *Mineral, Colorado.* Geology and Ore Deposits of the Chicago Creek Area, Clear Creek County. J. E. HARRISON, J. D. WELLS, *U.S. Geol. Surv. Prof. Paper* 319.

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Exploration, Statistical : *Uranium, Colorado.* An Application of Statistical Analysis to Exploration for Uranium on the Colorado Plateau. R. C. BATES, *Econ. Geol.*, May, 1959.

Structural, Canada : *Uranium, Saskatchewan.* Structural History of the Beaverlodge Area. J. A. CHAMBERLAIN, *Econ. Geol.*, May, 1959.

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